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Babcock and Wilcox Co., Lynchburg, Va. (USA).
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Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.
Methods of compliance with fracture toughness and operational requirements of 10 CFR 50, appendix G, 3:639 (BAW–10046A(Rev.1))

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Abey, A., *See* Schatz, J., 3:1561

Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-2} s^{-1}—and at high pressure, 3:1118 (UCRL–79012)

Abou-Sayed, A.S., *See* Jones, A.H., 3:202

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 56782, 56783

PROCESSING

REFER ALSO TO CITATION(S) 56788

CARBONIZATION

55925 (AED-Conf—77-517-001) **Coking industry: results and principles for the eighties.** Nashan, G. (Ruhrkohle A.G., Essen (Germany, F.R.)). 1977. 38p. (In German). (CONF-7710192—2). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Hard daycoal; Essen, F.R. Germany (24 Oct 1977).

The development of coke distribution in the past and the expectations for the future show that the targets for quantity and quality are essentially determined by the iron producing industries. After coke has been excluded from the heating industry it is only utilized for purposes where its properties as raw material are indispensable. Coke distribution will be stabilized on condition that raw steel production will have a positive development with regard to quantity if coke proves to be competitive. Coking industry can make a valuable mediate contribution in this area by securing low prices for coke; keeping the costs low requires links with mining industry, iron producing industry and chemistry which means: efficient production calls for locations in overcrowded regions. There the final conflict between efficient production and sensible environmental protection measures becomes more and more important although there is a frequent lack of objective standards. Keeping up locations in overcrowded regions and securing them, however, require a solution of environmental problems.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 55952, 55964, 55965, 55974, 55983, 56006

55926 (FE—2028-12) **Kinetics and mechanism of desulfurization and denitrogenation of coal-derived liquids. Tenth quarterly report, September 21-December 20, 1977.** Gates, B.C.; Katzer, J.R.; Olson, J.H.; Kwart, H.; Stiles, A.B. (Delaware Univ., Newark (USA)). 20 Jan 1978. Contract EX-76-C-01-2028. 130p. Dep. NTIS, PC A07/MF A01.

Three high-pressure flow microreactors and two batch autoclave reactors have been used to study the reaction networks and kinetics of: (1) catalytic hydrodesulfurization of dibenzothiophene and methyl-substituted dibenzothiophenes; and (2) catalytic hydrodenitrogenation of quinoline, methyl-substituted quinolines, acridine and carbazole. The catalysts were commercial, sulfided CoO-MoO_3/γ-Al_2O_3, NiO-MoO_3/γ-Al_2O_3, and NiO-WO_3/γ-Al_2O_3. At the typical conditions of 300°C and 104 atm, dibenzothiophene reacts to give H_2S and biphenyl in high yield, but there is some hydrogenation preceding desulfurization. Methyl-substituted dibenzothiophenes react similarly, and each reaction is first-order in the sulfur-containing compound. Two methyl groups near the sulfur atom (in the 4 and 6 positions) reduce the reactivity tenfold, whereas methyl groups in positions further removed from the sulfur atom increase reactivity about twofold. The results are consistent with steric and inductive effects influencing adsorption. The data indicate competitive adsorption among the sulfur-containing compounds. In quinoline hydrodenitrogenation, both rings are saturated before the C-N bond is broken. Similarly, in acridine conversion a large amount of hydrogenation precedes nitrogen removal. Breaking of the carbon-nitrogen bond is evidently one of the slower reactions in the network. The Ni-Mo catalyst is about twice as active as the Co-Mo catalyst for ring hydrogenation, and the two catalysts are about equally active for breaking the carbon-nitrogen bond. Reactivity of carbazole is slightly lower than that of quinoline but higher than that of acridine.

HYDROGENATION

REFER ALSO TO CITATION(S) 55977

55927 **Hydrogenation process for solid carbonaceous materials.** Cox, J.L.; Wilcox, W.A. (to Dept. of Energy). US Patent 4,155,832. 22 May 1979. Filed date 23 Dec 1977. 10p.

PAT-APPL-863,765.

Coal or other solid carbonaceous material is contacted with an organic solvent containing both hydrogen and a transition metal catalyst in solution to hydrogenate unsaturated bonds within the carbonaceous material. This benefaction step permits subsequent pyrolysis or hydrogenolysis of the carbonaceous fuel to form gaseous and liquid hydrocarbon products of increased yield and quality.

GASIFICATION

REFER ALSO TO CITATION(S) 55977, 55979, 55989, 56757

55928 (BNL—51010) **Flash hydropyrolysis of coal. Progress report No. 7, July 1-December 31, 1978.** Steinberg, M.; Fallon, P. (Brookhaven National Lab., Upton, NY (USA)). Feb 1979. Contract EY-76-C-02-0016. 156p. Dep. NTIS, PC A08/MF A01.

A considerable number of runs on the flash hydropyrolysis of lignite has been made and the data used in correlating the parametric study of the process chemistry. The production of gaseous hydrocarbons (methane and ethane) was studied as a function of the feed hydrogen to coal ratio. The gaseous yield was observed to vary with this ratio to the 0.18 power at pressures of both 1000 psi and 2500 psi. The rate of increase of gaseous yield was shown to be approximately 2 to 2.5% in yield for each 100 psi increase in pressure for H/coal ratios of both 1 and 0.25. The higher H/coal ratio produced an approximately 20% greater overall conversion than the lower ratio. Methane concentrations as high as 34.4% were produced in the process stream at a H/coal ratio of 0.23 and a temperature and pressure of 875°C plus 2500 psi. This high methane concentration is 60% of the thermodynamic equilibrium concentrations under these temperatures and pressures. Further attempts were made to operate the system at pressures of 3000 psi where plugging of the unit had been experienced earlier using lignite. Two runs were conducted, one at 750°C and the other at 825°C and although in both cases the reactor eventually plugged, sufficient data had been collected to consider the experiment completed. The data generated by the parametric study of lignite has been correlated and activation energies for a first approximation of the reaction scheme are presented. These range from 88 Kcal/mol for the formation of ethane and 62 Kcal/mol for the formation of benzene to 29 Kcal/mol for the formation of methane, all from the feed coal. The mechanism appears to be largely chemical reaction rate controlled as opposed to diffusion controlled.

55929 (CONF-790855—3) **Design and initial testing of high temperature/pressure samplers.** Bump, T.R.; Chang, H. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Denver, CO, USA (20 Aug 1979).

The ANL High Temperature/Pressure Samplers Program develops, under guidance of the Morgantown Energy Technology Center (METC), samplers for installation at selected locations in coal-process PDU, pilot, and eventually, demonstration plants, to improve monitoring of plant performance. Two samplers have already been designed and procured, a Non-insertable, Isothermal Gas Sampler and an Insertable Pyrometer. The former component is designed to collect gas samples near the wall of a water-cooled coal process vessel, such as the METC low-Btu gasifier, and deliver the gas isothermally to an analyzer. The sampler line heaters and their control console, which controls the heaters at the gas sample stream inlet temperature, have already been tested at 1500°F. Also, the pressure letdown system, which provides for a 300 psi drop from gasifier to analyzer, has been calibrated for use as a flowmeter. The Insertable Pyrometer is designed to penetrate into the interior of a pressurized coal-process vessel, such as the METC gasifier, and measure radial temperature distributions, to at least 2000°F. The reference probe houses a quartz rod that transmits infrared signals from the vessel interior to a signal analyzer outside the vessel. The entire component has already operated satisfactorily away-from-vessel. In addition, an Insertable, Combined, High-Velocity Thermocouple and Isothermal Gas Sampler, that combines many features of the first two components, has been designed and is under procurement. Finally, the conceptual design of a Coring-Type Solids Sampler has been completed.

55930 (COO—2904-13) **Chemical and physical stability of refractories for use in coal gasification. Thirteenth quarterly progress report, May 1-July 31, 1979.** Fakhr, A.; Day, D.E. (Missouri Univ., Rolla (USA)). 31 Jul 1979. Contract EY-76-S-02-2904. 30p. Dep. NTIS, PC A03/MF A01.

Various refractories have been exposed in pure steam and other atmospheres at pressures up to 1000 psia for 10 days with the flexural strength being measured before and after exposure. Cement-bonded castables and calcium aluminate cements were exposed to liquid water and saturated water vapor at 1000 psia. All the dense alumina castables had higher strength after exposure to either the saturated vapor or the liquid than their controls. This result has been attributed to the formation of additional bonding phase(s). Other measurements on these specimens are reported. Chemical reactions are proposed to explain the results. (LTN)

55931 (DOE/ET—0067/3) **Coal gasification. Quarterly report, July-September 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). May 1979. Contract EX-76-C-01-2297. 77p. Dep. NTIS, PC A05/MF A01.

To develop the most suitable techniques for gasifying coal, DOE, together with the American Gas Association, is sponsoring the development of several advanced conversion processes. Although the basic coal-gasification chemical reactions are the same for each process, each of the processes under development has unique characteristics. There are, for example, important differences in reactor configurations and in methods of supplying heat for gasification. Moreover, because these processes require high temperatures, because some require high pressures, and because all produce corrosive and chemically-active gases, resistant alloys and new pressure vessels must be developed to obtain reliable performance. A number of processes for making high Btu gas and for making low Btu gas are described with the contractor identification, contract, site, funding, and current progress. Projects on mathematical modeling and preparation of a coal conversion systems technical data book are also described. (LTN)

55932 (DOE/ET—0069/3) **Coal demonstration plants. Quarterly report, July-September 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). May 1979. Contract EX-76-C-01-2298. 67p. Dep. NTIS, PC A04/MF A01.

The objective of the Department of Energy's demonstration plant program is to establish the technical and financial feasibility of coal conversion technologies proven during pilot plant testing. Demonstration plants will minimize the technical and economic risks of commercialization by providing a near commercial size plant for testing and production. Thus, DOE is sponsoring the development of a series of demonstration plants, each of which will be a smaller version of commercial plants envisioned for the 1980's. These plants will be wholly integrated, self-sufficient in terms of heat generation, and dependent only on feedstock of coal, water, and air. Under the DOE program, contracts for designing, constructing, and operating the demonstration plants will be awarded through competitive procedures and will be jointly funded. The conceptual design phase will be funded by the government, with the detailed design, procurement, construction, and operation phases being co-funded, 50 percent from industry and 50 percent from the government. The cost involved in building and operating a demonstration plant will probably be between $200 million and $500 million, depending on the size of the plant. Two coal liquefaction and 5 coal gasification projects are described; these are mostly at an advanced design stage. Support projects for fuel feeding systems, values, instrumentation and process control, etc. are also described. (LTN)

55933 (DOE/ET/13108—1/1) **Site qualification studies of the UCG-SDB at North Knobs, Wyoming.** Davis, B.E.; Krajewski, S.A.; Ahner, P.F.; Avasthi, J.M.; Dolde, M.E.; Greenman, C.A.; Miranda, J.E. (Gulf Research and Development Co., Pittsburgh, PA (USA)). 1979. Contract EF-77-C-03-1472. 450p. Dep. NTIS, PC A19/MF A01.

The site qualification program for the North Knobs UCG site near Rawlins, Wyoming has been completed. This site will be the location for the field tests of Underground Coal Gasification of Steeply Dipping Beds undertaken by Gulf Research and Development Company for DOE in a cost shared contract. Site characterization included a comprehensive geotechnical analysis along with vegetation, historical, and archeological studies. The G coal seam chosen for these tests is a subbituminous B coal with a true seam thickness of 22 feet and has thin coal benches above and below the main seam. The water table is at 90 feet below the surface. Hydrologic studies have defined the seam as an aquiclude (non-aquifer). The site is deemed restorable to regulatory requirements. Evaluation of this site indicates total acceptability for the three-test program planned by GR and DC.

55934 (DOE/ET/13108—1/2) **Site qualification studies of the UCG-SDB at North Knobs, Wyoming.** (Gulf Research and Development Co., Pittsburgh, PA (USA)). 1979. Contract EF-77-C-03-1472. 312p. Dep. NTIS, PC A14/MF A01.

55935 (DOE/ET/20023—1) **Environmentally acceptable disposal of coal conversion solid waste residuals. Progress report, April 21-July 31, 1979.** Neufeld, R.D. (Pittsburgh Univ., PA (USA). Dept. of Civil Engineering). 1 Aug 1979. Contract EY-77-S-02-4579. 11p. Dep. NTIS, PC A02/MF A01.

Laboratory and report preparation activities are underway to investigate basic phenomena that would assist demonstration and commercial sized coal conversion facilities in the environmentally acceptable disposal of process solid waste residuals. Laboratory columnar and rapid leaching evaluations are being conducted in accord with RCRA guidelines and other techniques. Preparations are being made for Ames testing of derived leachates.

55936 (FE—1207-61) **Gas Generator Research and Development: BI-GAS process. Quarterly report, January-March 1979. (BCR Report L-981).** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Apr 1979. Contract EF-77-C-01-1207. 105p. Dep. NTIS, PC A06/MF A01.

The life test of catalysts BCR Lots No. 4104, 4105, 4106, and 4107 was completed. These catalysts are nickel-molybdenum catalysts containing various promoter metals which were expected to improve their thermal stability compared with earlier unpromoted nickel-molybdenum catalysts from the same supplier. The results, however, showed that the thermal stability of these promoted catalysts was not substantially improved over that of the earlier samples tested. Two catalyst samples, based on catalyst BCR Lot No. 4122, were received and a life test was initiated to compare the activities of these samples with those of their predecessors, BCR Lots No. 4122 and 3766. PEDU Test No. 34 employed a batch of the BI-GAS pilot plant methanation catalyst that had been used in two previous 5-day PEDU tests. The primary objective, operation at a hydrogen to carbon monoxide ratio of 1.4 for an extended period of time, was not achieved because loss of catalyst activity through carbon deposition made it difficult to keep the bed temperatures up within the desired range. PEDU Test No. 35 was conducted using a fresh batch of the Homer City methanation catalyst (BCR Lot No. 4263). After an initial baseline activity check under normal design conditions, the reactor was operated for nearly 80 hours in the combined shift/methanation mode, without steam, using a synthesis gas equivalent to the feed to the shift converter (steam-free basis) at the BI-GAS pilot plant (hydrogen to carbon monoxide ratio = 1.4). Average bed temperatures were kept in the range of 950°F. Useful conversions of 98% were obtained under these conditions, and, although the final carbon content of the catalyst was 1.4%, the catalyst showed no tendency toward deactivation throughout the 5-day test.

55937 (FE—2247-23) **Gasification of residual materials from coal liquefaction. Quarterly report, January-March 1979.** Robin, A.M. (Texaco, Inc., Montebello, CA (USA). Montebello Research Lab.). May 1979. Contract EX-76-C-01-2247. 12p. Dep. NTIS, PC A02/MF A01.

SRC-II vacuum flash drum bottoms from the liquefaction of Powhatan Coal is an excellent feedstock for the Texaco Synthesis Gas Generation Process. A Type III Extended Pilot Plant Evaluation of this material is recommended. Some dilution (~ 1%) with heavy distillate may be required for viscosity control in the pilot plant.

55938 (FE—2338-12) **Development of a modular software system for the dynamic simulation of coal conversion plants. Quarterly report, October-December 1978.** Schiesser, W.E.; Stein, F.P.; Johnson, S.H.; Caram, H.S.; Dissinger, G.R.; Chen, K.L. (Lehigh Univ., Bethle-

hem, PA (USA)). Jan 1979. Contract EX-76-C-01-2338. 39p. Dep. NTIS, PC A03/MF A01.

Three manuals have been appended to this report which give an introduction, a description, the coding, and some sample output for the dynamic gasifier model, dynamic compressor model, and the ideal-gas physical-properties package. The heat-exchange equipment which produces high-pressure steam and cools the process gas exiting from each methanation reactor has been modeled using a lumped-parameter model. The waste-heat boilers are modeled as four equal-volume tanks on the gas side. Each volume transfers heat to a constant-temperature sink at the temperature of saturated steam. The water preheaters are modeled as three equal-volume tanks on the water side and a single tank on the gas side. Heat is transferred from the gas-side tank to each of the water tanks. An energy balance around each tank gives one ordinary differential equation per tank. Thus, each preheater and waste-heat boiler are modeled by four ODEs. The preheater and boiler models have been successfully compiled, debugged, and integrated with the methanation reactor models. Several heat exchangers have been added to the steady-state simulation of the hydrogen plant which had been run previously with all of the chemical reactors in place. Graphical results are shown for the temperature profiles in all parts of the hydrogen plant. Dynamic models of the two shift reactors in the hydrogen plant have been tied together and run successfully.

55939 (FE—2355-36(Rev.N/C)) **Failure analysis report: Lockhopper Valve Type I, II and IV P/N 75895, S/N 3.** (Consolidated Controls Corp., El Segundo, CA (USA)). Jul 1979. Contract EX-76-C-01-2355. 128p. Dep. NTIS, PC A07/MF A01.

A Lockhopper Valve Type I, II, and IV (CCC P/N 75895) (S/N 3) was assembled in accordance with CCC Assembly Procedure FE-2355-28. This was the first unit assembled with a Ceramic/Refractory Composite Gate (CCC P/N 76273). The final steps in the assembly procedure involve adjusting the actuator to control the proper positioning of the gate to the open and closed positions. These adjustments require that the actuator be operated a number of times (three or four) to obtain proper positioning. The actuator was also operated a number of times in order to inspect the gate location. After these few operations, obvious grinding, gritty noises were heard emanating from the gate area during cycling. Operations were immediately stopped. Subsequent operation and inspection showed scratches on the inlet and outlet seats and chipping on the gate seal disc. Operation was halted and the valve was disassembled. On disassembly, the gate refractory was found to be broken at the narrow section around the seal disc, the seal disc was scored and chipped, the wear inserts were heavily scored, and the inlet and outlet seats were scored and chipped. The failures were inside the valve at the time of failure and out of sight, so any analysis must be somewhat speculative. Nevertheless, the failures can be directly attributed to the wear inserts, high spring loading, and/or sharp edges on the inlet seat. It is unlikely that the gate broke before the other damage, for instance, in view of the large excess strength and in view of another similar design which did not have any problems. Various other scenarios have been considered, but none adequately explain the damage encountered. (LTN)

55940 (FE—2416-43) **Conceptual design of a coal-to-methanol-to-gasoline commercial plant: executive summary. Second interim final report, August 31, 1977-March 1, 1979.** (Badger Plants, Inc., Cambridge, MA (USA)). Mar 1979. Contract EX-76-C-01-2416. 53p. Dep. NTIS, PC A04/MF A01.

This second Interim Final Report for the United States Department of Energy (DOE) presents in five volumes an engineering and economic assessment of a conceptual design for a commercial facility to convert coal-to-methanol-to-gasoline. Highlights from the report are summarized. As in the Coal-to-Methanol Report (FE-2416-24) issued February 1978, this design is conceptual and, therefore, is considered to be a prediction of the development of the technology in question and thus appropriate for comparative economic evaluation purposes. However, significant development work remains to be done in certain areas, such as the high pressure/high temperature slag bath gasifier and its associated systems. It must therefore be recognized that, in all likelihood, a project based on the current state-of-the-art or first plant will not achieve all of the economies of scale projected in this conceptual design, particularly with regard to the slag bath gasifier.

55941 (FE—2561-4) **Conversion of Rapid City Pilot Plant. Phase II. Reliability assessment of char transfer lines and ash lock hoppers, using fault tree analysis. Phase II, Addendum report for Task 3, September 15, 1978-January 9, 1979.** Somers, E.V. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Jan 1979. Contract EF-77-C-01-2561. 41p. Dep. NTIS, PC A03/MF A01.

The two-stage pressurized low Btu fluid-bed gasification process is being developed on a process demonstration unit (PDU) that gasifies about 0.6 ton of coal per hour (tph). Recognizing the need to scale the development to a larger size, US DOE contracted with Westinghouse to evaluate the possible conversion of the CO_2-Acceptor Pilot Plant to this pressurized gasification process to operate at 2.5 tph. The contract called for two phases: (1) to establish conceptual designs for the Rapid City plant; and (2) to establish a preliminary and more detailed plan for converting the CO_2-Acceptor Plant to this gasification process. The work on both these phases has been completed and reported. The contract was extended to include two additional tasks: (1) to develop a computer program and User's Manual for the heat and mass balances for the pressurized fluidized-bed gasification process; and (2) to analyze reliability of the char transfer line and ash lock hoppers by fault trees. The first additional task was completed and reported. This report describes the analyses and results of the second additional task.

55942 (METC/CR—79/6) **Specification requirements for a control valve for hot dirty gas service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 6p. Dep. NTIS, PC A02/MF A01.

The conditions for this valve were derived from the Illinois Coal Gasification Group (ICGG) COGAS process high-Btu demonstration plant. This Hot Dirty Gas Flow/Pressure Control Valve is required to control the pressure in the gasifier and the flow rate to the pyrolyzers. The service conditions are specified. (LTN)

55943 (METC/CR—79/8) **Test plan for a control valve for hot, dirty gas service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 26p. Dep. NTIS, PC A03/MF A01.

This test plan covers a hot, dirty gas valve used for back pressure or flow control in a coal gasification or combined-cycle facility. Since large-scale (commercial size) testing facilities do not exist, and would be very expensive and time-consuming to construct, this test plan assumes that valves will be tested in relatively small-scale test loops. The purpose of this plan is to define the objectives, tests, methods, measurements, evaluation criteria, and data requirements for the hot, dirty gas valve tests. This plan will be used initially as a basis for test equipment design and for coordination of activities among the government and contractor organizations involved in the valve program. As the valve designs and test equipment designs progress, this test plan will be revised to reflect the changes. In its final form, the test plan will be the basis for detailed test and evaluation procedures, instrumentation and data analysis requirements. The overall objective of the hot dirty gas control valve test program is to assure the availability of valve designs to operate within performance specifications with high reliability, long life, and minimal maintenance under severe operating conditions, which include high temperature (up to 1800°F) and corrosive and erosive media at intermediate pressure ranges (50 to 500 psi).

55944 (METC/CR—79/10) **Facility requirements for testing control valves for hot dirty gas service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 24p. Dep. NTIS, PC A02/MF A01.

METC has initiated new valve test and development projects. This test plan covers a hot, dirty gas valve used for back pressure or flow control in a coal gasification or combined-cycle facility. Since large-scale (commercial size) testing facilities do not exist, and would be very expensive and time-consuming to construct, this test plan assumes that valves will be tested in relatively small-scale test loops. Included in this document are the program objectives, a description of the tests, and the facility functional requirements criteria.

55945 (METC/CR—79/12) **Design criteria for a control valve for hot dirty gas service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 20p. Dep. NTIS, PC A02/MF A01.

These design requirements are applicable to valves suitable for use in controlling hot, dirty gas in coal gasification processes. The valves are in service following the gasifier and two cyclones, which remove solid particles above 60 micron size. The hot, dirty gas contains contaminants that are both corrosive and erosive to materials that come in contact with them. In the past, almost all coal-gasification processes have used wet scrubbers directly following the gasifiers to clean and cool the product gases. In the near future, advanced processes, including the COGAS Process, will be constructed. Some of these processes require control valves for throttling hot dirty gas. The commercial development of these advanced processes could be delayed if reliable valves are not available for this severe service. The design and construction of the valves shall comply with commercial standards as defined in ANSI B16.34-1967. It should be noted that the valves will be used in piping systems that conform to the ASME Boiler and Pressure Vessel Code and the ANSI Code for Pressure Piping. Therefore, the valves are also subject to any limitations of those Codes. In the case of a conflict in requirements in these Codes, the more stringent (i.e., more conserva-

tive) requirement shall apply. The valves shall be designed to be remote operating type valves.

55946 (ORNL/Sub—7240/4) **Evaluation of the Battelle Agglomerating Ash Burner Process for the production of medium Btu gas.** Chang, T.Y.; West, A.S. (Scientific Design Co., Inc., New York (USA)). Jun 1979. Contract W-7405-ENG-26. 140p. Dep. NTIS, PC A07/MF A01.

The Battelle Agglomerating Ash Burner Process is in an early developmental stage. As a means for determining the magnitude of the incentive for expenditure of further development effort on this process, conceptual process design and associated cost estimates were prepared on the basis of anticipated, but unproven, process and equipment performance. On the basis of the postulated performance, the estimated cost for the product gas, assuming private financing, is $2.82/MM Btu. It is concluded that the process merits further development.

55947 (SAND—79-1022C) **Site selection and characterization for an underground coal gasification process.** Bartel, L.C. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 12p. (CONF-791107—1). Dep. NTIS, PC A02/MF A01.

From 49. annual international SEG meeting; New Orleans, LA, USA (4 Nov 1979).

Geologic and hydrogeologic features influence the success of the underground coal gasification (UCG) process. It is desirable to perform the UCG process at sites having optimal conditions, or at least the site detailed to take advantage of geologic and hydrogeologic features. A site selection and characterization program is taking place in the State of Washington and elements of this program are outlined in this paper. The selection and characterization studies for a commercial UCG process need to be economical which precludes the extensive use of borehole surveys. The program outlined helps to establish criteria for the use of less expensive surface techniques in the initial site selection and characterization phases for a commercial process and to establish adequate characterization procedures which require a minimum number of boreholes. Examples will be given of information obtained from surface geophysical techniques employed at the Hanna IV site and the Gulf site west of Rawlins, WY, and examples will also be given of information that can be obtained from well logs.

55948 (TIS—6250) **Coal gasification for power plant fuel.** Patterson, R.C. (Combustion Engineering, Inc., Windsor, CT (USA)). 1979. Contract EX-76-C-01-1545. 13p. (CONF-790387—1). Dep. NTIS, PC A02/MF A01.

From VGB conference on gasification of coal in power engineering; Dortmund, F.R. Germany (27 Mar 1979).

Combustion Engineering, Inc. is a major supplier of stack gas scrubbing systems in the United States, and has active development programs underway in gasification, solvent refining and fluid bed combustion. These development programs are in response to the growing need for economical and environmentally-acceptable methods to use coal to produce electric power. Although primary development in the United States has emphasized gasification processes that produce substitute natural gas (SNG), C-E was not convinced that SNG processes were the proper approach for the bulk production of electric power. C-E's early reviews of these emerging technologies raised questions about the necessity for and economy of pressurized, oxygen-blown gasification, if the end-use of the product gas was to be an environmentally-acceptable fuel for firing power plant boilers and gas turbines. Low-Btu gasification of coal has the greatest potential for meeting both environmental and economic goals. The principal recommendation resulting from the preliminary phase work was that an air-blown, atmospheric pressure, entrainment gasification system should be developed at once. Such a system is the simplest kind to design, build and operate, and has the fewest hardware development requirements. In late 1974, OCR signed a second contract with C-E to conduct necessary R and D and to design, build and operate a 5 ton-per-hour coal gasification process development unit (PDU) for experimental verification of the process and equipment. The PDU was designed and built at C-E Power Systems headquarters site in Windsor, Connecticut, and the plant has been in operation for nearly a year.

55949 **Hot sand-coal-cracking to hydrodistillate fuels.** Leas, A.M. US Patent 4,147,615. 3 Apr 1979. Filed date 12 Apr 1977. 14p.

Fuel liquids and gases from a hydrocarbonaceous material such as coal may be produced by contacting the material with an iron group metal silicide, preferably cobalt and/or iron silicide. Also, an iron group metal silicate, preferably cobalt and/or iron silicate, provides a solid source of additional oxygen in the combustion of a carbonaceous fuel with oxygen. Carbon-coated sand, such as that produced in coal conversion utilizing an iron group metal silicide sand, is utilized in reduction of oxidic iron ores.

55950 **U-gas technology status.** Patel, J.G. Chicago, IL; Institute of Gas Technology (1979). 25p. (CONF-790598—2).

From Institute of gas technology symposium: advances in coal utilization technology; Clarksville, IN, USA (14 May 1979).

The U-GAS Process has been developed by the Institute of Gas Technology to produce a low- to medium-Btu (150 to 300 Btu/SCF) fuel gas from coal in an environmentally acceptable manner. The process accomplishes decaking, devolatilization, and gasification of coal in addition to separation of ash in a single-stage fluidized-bed reactor. A 24-ton per day pilot plant has been successfully operated on a variety of feedstocks including a high-sulfur, caking Illinois basin bituminous coal. The total operating time for the pilot plant has been over 5600 hours, during which more than 100 test runs have been conducted. A raw product gas having a heating value of 280 Btu/SCF and ash agglomerates containing 95% ash have been produced in the pilot plant. This corresponds to an overall gasifier coal utilization efficiency of up to 94%. Recent operation of the pilot plant has firmly established process feasibility, safe and reliable operability, and provided a strong data base for the preliminary design of a demonstration plant. The U-GAS Process has been selected by the U.S. Department of Energy and Memphis Light, Gas and Water Division (City of Memphis) for the preliminary design of a demonstration plant. The plant, proposed for construction in Memphis, will produce 50 billion Btu of an industrial fuel gas daily from 2800 tons of coal. Currently, based on successful pilot plant tests, the demonstration plant preliminary design is underway and is to be completed in November 1979.

55951 **U-GAS process for ammonia manufacture.** Patel, J.G.; Leppin, D. Chicago, IL; Institute of Gas Technology (1979). 24p. (CONF-790599—1).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

The U-GAS Process can be used to produce ammonia synthesis gas. The cost of production of synthesis gas from coal via thia process should be competitive with other coal gasification processes but current prices of natural gas and other alternative fuels are being controlled at such levels that no coal gasification-based ammonia plant will provide investors with an adequate return. It is important to obtain a domestic experience base with coal gasification so that correct assessments of coals suitability as a feedstock for ammonia manufacture, methanol production, industrial and domestic fuel gases, and other applications can be made.

55952 **Acid-gas removal systems in coal gasification.** Fleming, D.K. Chicago, IL; Institute of Gas Technology (1979). 28p. (CONF-790599—21).

From Ammonia-from-coal symposium; Muscle Shoals, AL, USA (8 May 1979).

A large number of acid-gas removal systems exist or are under development for the removal of H_2S and CO_2 from process gas streams. A few systems have been applied to coal conversion processes; others will require extrapolation of presently-proved commercial operation. The feed to the acid-gas removal system for the generic coal-to-ammonia facility is not well-defined; particularly for minor and trace constituents. This is particularly true in the case of newer gasification processes that may have significant economic advantages in the overall process when evaluated on a total systems analysis approach. A number of species that could be present in the gas fed to the acid-gas removal system are discussed; the design of that subprocess should consider the fate of these species from both an environmental and an economic standpoint. In an overall evaluation, it appears that acid-gas removal systems can be successfully applied in coal conversion; no technical obstacle has yet been discovered to restrict their application.

55953 **Hygas process: coal to SNG.** Lau, F.S.; Bair, W.G. Chicago, IL; Institute of Gas Technology (1979). 22p. (CONF-7905100—1).

From American Gas Association transmission conference; New Orleans, LA, USA (21 May 1979).

The United States is extremely rich in coal and it is in the national interest to use this resource to the greatest extent possible. The HYGAS Process is an economic, efficient, and environmentally acceptable method of producing highly desirable substitute natural gas (SNG) from our coal. HYGAS Process concepts and the HYGAS Pilot Plant are described in this paper. The details of key tests from campaigns using major U.S. coal types (lignite and bituminous) are presented. In conjunction with the proven versatility of the process, commercial/demonstration design projects have been undertaken by the C.F. Braun Co. and Procon, Inc., and the economic implications of these studies are discussed.

55954 **Proceedings of the coal processing and conversion symposium.** Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979). 128p. (CONF-7606193—). The Publisher, P.O. Box 879, Morgantown, WV.

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

The Coal Processing and Conversion Symposium was held June 1-3, 1976, at Morgantown, WV. It was sponsored by the West

Virginia Geological and Economic Survey and the West Virginia University, College of Engineering. Individual papers from the proceedings have been entered into EDB and ERA. (LTN)

55955 In situ gasification of eastern coals. Shuck, L.Z.; Pasini, J. III. (Morgantown Energy Research Center, WV). pp 49-60 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

The underground gasification of eastern U.S. coals presents some unique advantages and disadvantages in comparison with other coal deposits in the U.S. A program at the Morgantown Energy Research Center for the development of eastern coal in situ gasification technology is described. Investigations at the micro, macro, and global levels are conducted in order to define the controlling mechanisms. The program includes simultaneous theoretical, laboratory and field projects. Theoretical studies analyze and characterize the dynamic individual and interaction effects from reaction kinetics, mass and energy transport, and tectonic and thermal-induced stress fracturing processes. Laboratory studies include thermal, structural, electromagnetic, and resistivity property measurements prior to and during gasification. Process simulation and optimization experiments are conducted on bituminous, subbituminous, and lignite, under different gasification schemes and conditions to delineate different controlling mechanisms. Experiment parameters are adjusted to provide optimum results while the experiments are in progress. This is accomplished by computer real time data reduction and analysis. The field research project utilizes the Longwall Generator Concept of parallel, directionally drilled holes for accessing the coal bed in terrain where closely spaced vertical wells are not practical. This concept provides the opportunity for better directional control of the advancing gasification process and greater total resource recovery efficiency. The field project is an attempt to gasify a 900 foot deep, 6 foot thick bed of high volatile, low permeability Pittsburgh coal. These general conditions are representative of numerous coal beds in the Eastern United States close to large power demand centers.

55956 Cost analysis of pressurized, fixed-bed gas producers. Bissett, L.A.; Nichols, D.G. (West Virginia Univ., Morgantown). pp 71-79 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

Fixed-bed gas producers, which contact air and steam with coal to produce gas with heating values of 100 to 170 Btu/SCF, can potentially be used for industrial heating and combined-cycle electrical power generation. Data from experimental runs with Pittsburgh No. 8 and Upper Freeport seam coals in a pressurized fixed-bed producer at the Morgantown Energy Research Center were correlated with linear regression techniques. Yields for the primary gas compounds were correlated as functions of key operating conditions. These correlations were used in a computer model simulation of a gas producer plant. Total investment costs, working capital, annual operating costs, and selling costs were computed as a function of plant size.

55957 Coal devolatilization studies in support of the Westinghouse fluidized bed coal gasification process. Morris, J.P.; Kearns, D.L. (Westinghouse Research Labs., Pittsburgh, PA). pp 81-94 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

Coal devolatilization studies are being carried out with a pressurized laboratory fluidized bed reactor. The tests show the behavior of caking and noncaking coals during rapid heating in a fluidized bed. Small samples of coal are injected into a hot bed of char; the off-gas is sampled and analyzed; and the char and agglomerates produced are examined and characterized. Data obtained on the variation of gas evolution rates with time are used to predict the duration of the plastic or sticky phase during transition of the coal to char. All tests were conducted at 10 atm pressure; bed temperature and coal particle size were varied.

55958 Materials and component failures in coal conversion. Nowak, J.J.; Ferretti, E.J. (Dravo Corp., Pittsburgh, PA). pp 95-104 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

This paper briefly discusses corrosion problems and material and component failures in coal gasification and liquefaction facilities. Reported failures in operating pilot plant and bench scale systems, and remedial measures taken are described. Current programs evaluating materials of construction for coal gasification and liquefaction systems and some of the results are discussed. In summary, the corrosion and materials failure problems are most severe in the high temperature, high pressure operations: gasifier reactors, slag/ash removal systems, and the raw gas quench systems. Little is known so far about the true role of combined gasification products and coal contaminants under gasification conditions. To eliminate or at least reduce the number of material failures will require a complete identification of the gaseous products.

55959 Analysis of conduction responses during an underground coal gasification experiment. Hommert, P.J. pp 153-158 of International heat transfer conference. Vol. 2. Toronto, Ontario; National Research Council of Canada (1978).

From 6. heat transfer conference; Toronto, Canada (7 Aug 1978).

From March to July 1976, the Laramie Energy Research Center (LERC) conducted an underground coal gasification experiment in a 9-m thick sub-bituminous coal seam near Hanna, Wyoming. Sandia Laboratories designed and fielded an extensive instrumentation array which included approximately eight thermocouples within the seam in each of 15 diagnostic wells. The instrumentation provided thermal data related to the process during both reverse combustion linkage and forward gasification. Portions of these data which were suitable for analysis by inverse heat conduction techniques included the responses from the approximately cylindrical reverse combustion linkage path and the responses at thermocouples outside the gasified zone due to conduction from the final boundary. Because of the effects of property variations and water vaporization on the conduction response, an exact analytical solution could not be used. Instead, the approach was to adjust parameters of the constant property analytical solutions to fit numerical calculations that included property variations and water vaporization. Sensitivity studies were performed to estimate the accuracy of solutions obtained. These indicated that parameters relating to size and distance should be identifiable within plus or minus0.25 m; however, accurate estimates of temperature could not be obtained. Results allowed the position of the reverse combustion linkage path to be mapped, and estimates of its size (approximately 1 m in diameter) and average temperature (750° K-1000° K) to be obtained. With respect to forward gasification, the analysis yielded estimates of the final boundaries established by the burn and characterizations of how the front approached its final position.

55960 Efficient methanation in coal gasification. Pennline, H.W.; Schehl, R.R.; Haynes, W.P. (US DOE, Pittsburgh, Pa). *Coal Process. Technol.;* **4**: 4-12(1978).

Design details are presented for a new hybrid methanator which demonstrates an efficient method for removing the exothermic heat of methanation. This methanator offers long catalyst life and good carbon monoxide conversion.

55961 Grand Forks slagging gasifier. Johnson, B.C.; Schbert, H.H.; Fegley, M.M. (US DOE, Grand Forks, ND). *Coal Process. Technol.;* **4**: 94-98(1978).

A progress report is presented on the pilot plant studies of a fixed-bed process leading to plans for demonstration-scale plant to be based on this process. It is shown that oxygen-steam ratio has a great effect on slagging conditions. Too low a ratio will not supply sufficient heat to maintain slag flow. Too high a ratio will produce too much heat, which can vaporize components of the ash and cause bridging in the fuel bed when the vapors condense in the cooler upper zones. The range of oxygen-steam ratio which has been found to be acceptable in slagging gasification is approximately 0.7 to 1.2. However, the range for most lignites (based on past experience in the GFERC gasifier) is more limited -0.9 to 1.1. The rate of oxygen and steam injection is the major factor controlling the gas production rates in the gasifier. The velocity at which the steam-oxygen mixture enters the gasifier through the tuyeres is an important factor in slagging operation. The gasifier pressure also has a significant effect on the performance and operational characteristics of the reactor.

LIQUEFACTION

REFER ALSO TO CITATION(S) 55926, 55932, 55935, 55937, 55949, 55954, 55958, 55963, 55981, 56785, 56789, 56792, 56793, 56797, 56801, 56805, 56806

55962 (ANL/CEN/FE—78-7) **Description, calibration, and preliminary testing of the coal liquefaction heat transfer coefficient measurement test unit.** Mulcahey, T.P.; Lo, R.N.K.; Bump, T.R.; Mulcahey, M.E.; Fischer, J.; Cannon, T.F.; Brock, R.E.; Wilson, W.I.; Bowyer, D. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

The efficiency of energy utilization within coal-liquefaction process is of major significance to the commercialization of the

process. Heat exchange equipment is also one of the major economic investments in new plants. Consequently, reliable heat transfer data are required for the economical design of heat exchange equipment. Since accurate heat transfer coefficients of coal slurries, especially with a gas phase present, cannot be accurately calculated from known physical data for the operational conditions found in the coal-liquefaction process, experimentally determined heat transfer coefficients under actual process conditions are needed. A liquefaction heat-transfer-coefficient measurement test unit for a nominal one-half-ton-per-day coal slurry was constructed, calibrated, and operated at ANL. This test unit was built to determine heat transfer coefficients needed for design of feed-heat and effluent-heat exchangers used in coal-liquefaction processes. The heat-transfer test module was substituted for the preheater and reactor used in the normal coal-liquefaction process. The heat transfer coefficient can be evaluated for the heat transfer between the three-phase feed and effluent fluids in turbulent flow and a heated or cooled stainless steel surface. A description is presented of the unit and its capabilities, calibration procedures and results, and preliminary operation and data analysis. Recommendations are made that should improve accuracy and ease of operation and data analysis of the test unit.

55963 (CONF-790822—13) **LC-Fining of SRC: a logical second stage in two-step coal liquefaction.** Chillingworth, R.S.; Hastings, K.E.; Potts, J.D.; Unger, H. (Cities Service Co., Tulsa, OK (USA). Technology Assessment Dept.; Lummus Co., New Brunswick, NJ (USA)). 20 Aug 1979. Contract EF-76-C-01-2574. 27p. Dep. NTIS, PC A03/MF A01.

From 87. AICHE national meeting; Boston, MA, USA (19 Aug 1979).

In conclusion, it may be stated that: Recycle processing of SRC-I coal extract produced an equilibrium recycle solvent containing 9 weight percent hydrogen after two recycle passes in the PDU; no refractory 850°F+ material was detected when recycling 500°F+ material; an 850°F+ conversion of approximatly 87 weight percent (based on fresh SRC-I feed) was obtained during recycle processing at temperatures of 790 to 810°F; a distillate product (390 to 850°F) containing < 0.3 weight percent nitrogen was routinely obtained during recycle processing at the above noted high conversion; and in the recycle mode of processing coal extract at 780°F, a catalyst addition rate of one pound of catalyst per ton of moisture-free coal gave an 850°F+ conversion of 62 weight percent (based on fresh SRC-I feed) and a nitrogen content in the distillate fraction (390 to 850°F) of 0.36 weight percent.

55964 (DOE/ET—0068/3) **Coal liquefaction. Quarterly report, July-September 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). May 1979. Contract EX-76-C-01-2297. 65p. Dep. NTIS, PC A04/MF A01.

DOE is supporting the development of several conversion processes that are currently in the pilot plant stage. Each of these processes is described briefly and information given as to contractor, contract, funding, site and current progress. Several support projects are treated similarly. (LTN)

55965 (FE—2047-11) **Clean solid and liquid fuels from coal. Quarterly progress report, October-December 1978.** Gary, J.H.; Golden, J.O.; Bain, R.L.; Dickerhoof, D.W. (Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering). Mar 1979. Contract EX-76-C-01-2047. 44p. Dep. NTIS, PC A03/MF A01.

Effort in the experimental continuous coal processing area was devoted to data collection with the CSM continuous unit operating in the tubular flow reactor mode. Experiments were performed to collect data at 360°C and residence times of 12.5, 15.5, 24, and 27 minutes. Additional data were collected using only the preheater, with an exit temperature of 360°C, in order to obtain reactor inlet concentrations of ash, unreacted coal, preasphaltenes, asphaltenes, and oils. These data are needed for future isothermal reactor modeling studies. Much effort has been devoted to further analysis of the continuous stirred-tank reactor runs made previously, concentrating on desulfurization, H to C ratios of the SRC product, and conversions to preasphaltenes, asphaltenes, and oils. Preliminary graphical comparisons of yield structure were made for continuous experiments versus batch experiments. The catalytic hydrodenitrogenation study was completed. One experimental run was made using a solids-containing feed in a trickle-bed reactor packed with a Ni-Mo catalyst for comparison to earlier runs made in the same reactor using solids-free feed oil. As was expected the data indicated much less catalyst activity and much faster catalyst poisoning than obtained before, indicating that catalytic HDN processing of coal derived liquids should be performed after unreacted coal and mineral matter have been separated from the liquid portion of the products.

55966 (FE—2454-6) **Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, October-December 1977.** Guin, J.A.; Tarrer, A.R. (Auburn Univ., AL (USA). Coal Conversion Lab.). 1978. Contract EX-76-S-01-2454. 120p. Dep. NTIS, PC A06/MF A01.

The effect of the initial particle size of a coal on the resulting particle size of the reacted products was determined by Coulter Counter analysis of liquefaction products of Amax and Kentucky coals. Further studies of the effect in coal dissolution with different solvent/coal ratios with four different solvents (tetralin, LRO, creosote oil, naphthalene) were performed using different reaction times. Extensive studies with SRC residue ash and coal ash as possible liquefaction catalysts were done in hydrogenation, hydrodesulfurization, and solvent quality of the coal liquefaction process. In the presence of Co-Mo-Al as catalyst and tetralin as solvent the reactivity of demineralized coal by acid extraction and magnetic separation was found to be almost the same as the untreated coal. Mineral matter present in coal strongly interacted with the LRO solvent, enhancing both the dissolution and hydrogenation reactions, but not with the tetralin solvent. Coal minerals such as Fe, SRC residue ash and pyrite had moderate hydrodesulfurization activity using phenyl sulfide, but not with dibenzothiophene. Mathematical modeling of reaction kinetics in coal liquefaction with tetralin as the solvent was done by the Parameter Estimation Method.

55967 (FE—2468-52) **ESCOE engineering program. Quarterly report, March 1-May 31, 1979.** (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). 8 Jun 1979. Contract EF-77-C-01-2468. 19p. Dep. NTIS, PC A02/MF A01.

ESCOE is conducting a process review to confirm that the reactor conditions being developed for the various projects include the combinations expected to yield optimum results; and an economic review, with particular emphasis on capital costs estimates since these become a major portion of the production costs. ESCOE is conducting a technical evaluation of materials for energy technology to prevent major materials and system failures, thereby improving plant operability, and developing materials standards and specifications for coal conversion and use processes. A systematic technique is being developed for assessing the opportunities, constraints, cost and impacts associated with the conversion of oil- and gas-fired electric power plants in a single geographic region to coal or coal-derived fuels. The technique is being applied to the New England region. ESCOE is providing continuing support to the MIT effort to develop a complex coal conversion process design simulator assuring efficient coordination between government and private experts. Guidelines were developed for use in preparing and reporting engineering designs, cost estimates and financial analyses of large-scale fossil energy facilities. They provide a uniform basis for presenting project expectations so that comparison between alternative projects can be done on a consistent basis by the US Department of Energy and therby assist in the establishment of technical development priorities. A number of other projects are described briefly. (LTN)

55968 (IS—4702) **Alloy evaluation for fossil fuel process plants (liquefaction). Quarterly report, January 1-March 31, 1979.** Woods, C.M.; Scott, T.E. (Ames Lab., IA (USA)). 15 Apr 1979. Contract W-7405-ENG-82. 29p. Dep. NTIS, PC A03/MF A01.

Room temperature mechanical properties were determined for A387-74A-Gr.22-Cl.2 steel after exposure for 856 hours at 800°F in a coal slurry with 4000 psig hydrogen pressure. Comparison of ambient condition tensile tests of the exposed samples with base property data revealed that no degradation of ambient temperature mechanical properties occurred. Examination of an Inconel rupture disc that failed during the attempted 1000 hour slurry-H_2 exposure revealed considerable pitting and corrosive attack by the environment above the slurry. Cross sectional area measurements of specimens exposed to a coal slurry environment for 856 hours showed inward growth of scale with subsequent loss of sample diameter. Scale growth was considerably greater on stressed samples than on unstressed samples. Microstructural examination of samples from all exposure conditions run to date showed no dramatic changes with the exception of the apparent formation of spherical precipitates near the sample's surface. These have yet to be identified. Scanning electron micrographs were made of the fracture surfaces of unexposed smooth-bar and notched-bar tensile samples and compared to micrographs of like samples exposed for 856 hours in a coal slurry at 800°F in 4000 psig H_2 gas. No apparent change in fracture appearance was noted. The micrographs showed a characteristic ductile-dimple type failure. Spherical particles lying at the base of many of the large voids visible in the fracture surfaces of all the samples examined were analyzed using point source x-ray fluorescence and found to consist of mainly Mn, S, Si and Fe.

55969 (IS—4710) **Alloy evaluation for fossil fuel process plants (liquefaction). Quarterly report, 1 April 1979-30 June 1979.** Woods, C.M.; Scott, T.E. (Ames Lab., IA (USA)). 15 Jul 1979. Contract W-7405-ENG-82. 9p. Dep. NTIS, PC A02/MF A01.

Due to the safety hazards associated with high temperature and high pressure hydrogen gas, we were unable to do any coal slurry exposure testing during the construction of our new test chamber. The entire quarter was spent repairing and inspecting the

mechanical components of our test facility and building new testing systems for doing fracture mechanics tests. A new pressure loss detector alarm system was installed to notify us of rupture disc failures, etc. Several brass check valves on the low pressure hydrogen manifold had to be replaced because of sustained load crack growth and failure. A new explosion proof cell has been constructed as an addition to the high pressure hydrogen test facility. A five inch I.D. autoclave has been ordered and we are presently awaiting its arrival. A test system including load cell, load train and specimen grips was designed and built in order to do J/sub IC/ testing.

55970 (METC/CR—79/7) **Specification requirements for a control valve for slurry letdown service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 8p. Dep. NTIS, PC A02/MF A01.

The conditions for this valve were derived from the Gulf Science and Technology Company SRC-II process demonstration plant. The first valve (V1) must let down pressure from 2000 psi to 460 psi, a total ΔP of 1540 psi, with the other valves (V2, V3, V4) each experiencing a lesser drop. It should be noted that temperatures throughout the pressure letdown system are, at the lowest, seven hundred and seventy-five degrees Fahrenheit, but with a possible maximum to eight hundred degrees Fahrenheit. Due to the carcinogenic nature of certain compounds in the coal slurry, the maintenance of valves in the field and under process run conditions is inadvisable. All maintenance will be performed during regularly scheduled annual turnaround periods, at which times all lines carrying slurry can be flushed with solvent and steam prior to opening up for maintenance. With the above constraints, it has been determined that letdown stations to each vessel will have a group of letdown valves in parallel. Each will have a tight shutoff block valve or valves upstream of the letdown valve. Thus, as a letdown valve becomes eroded to the point of uncontrollability, it may be isolated and the secondary valve put into service.

55971 (METC/CR—79/9) **Test plan for a control valve for slurry letdown service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 28p. Dep. NTIS, PC A03/MF A01.

METC has initiated new valve test and development projects. This test plan covers a valve for slurry letdown service in a coal liquefaction plant. Since large scale (commercial size) testing facilities do not exist, and would be very expensive and time consuming to construct, this test plan assumes that valves will be tested at an existing pilot plant facility or in special, small scale test loops. The purpose of this document is to define the objectives, tests, methods, measurements, evaluation criteria and data requirements for the slurry letdown valve tests.

55972 (METC/CR—79/13) **Design criteria for a control valve for slurry letdown service.** Gardner, J.F. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Jun 1979. 20p. Dep. NTIS, PC A02/MF A01.

These design requirements are applicable to valves suitable for use in controlling a coal/ash-solvent slurry under pressure letdown conditions in a coal liquefaction process. The valves are in the main flow downstream of the reactor vessel. The slurry also contains dissolved gases, including hydrogen, hydrogen sulfide and hydrocarbons. This valve must operate on a coal/ash-solvent slurry at 500 to 850°F and with letdown pressures from 2000 to 4000 psig to atmospheric. The design and construction of the valves shall comply with commercial standards as defined in ANSI B16.34-1977. It should be noted that the valves will be used in piping systems that conform to the ASME Boiler and Pressure Vessel Code and the ANSI Code for Pressure Piping. Therefore, the valves are also subject to any limitations of those codes. In case of a conflict between requirements in these codes, the more stringent (i.e., more conservative) requirement shall apply. The valves shall be designed to be remote operating-type valves.

55973 Coal liquefaction at Cresap, West Virginia. Finch, H.L. (Liquefied Coal Development Corp., Moundsville, WV). pp 62-70 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

The current Cresap program is not an extension of the Consol effort, but rather a new program with new and broader objectives. A wide-ranging program of equipment and materials testing and development is planned in order to achieve reliable operation of all components in the liquefaction system. Integration of the total facility to achieve maximum liquid yield (low-sulfur fuel oil) is necessary to perform required process studies and to fully implement planned equipment development work.

55974 Two-stage coal liquefaction. Karr, C. Jr.; Abel, W.T. (Morgantown Energy Research Center, WV). pp 105-115 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

Two-step coal hydroliquefaction runs have been conducted which indicate that by a suitable first-step reactor packing of nominally non-catalytic material, a coal/recycle oil slurry may be subjected to a hydropyrolytic pretreatment to yield an improved product. This product, after removal of mineral residues, allows a second-step reactor catalyst to perform at higher activity and relatively low temperature (380°C) and low hydrogen pressure (1500 psig) to give a better product. The best pretreatment operating conditions found to date were with an alpha-alumina packing at 440°C and 1500 psig. Further studies need to be made to establish the limits of operating parameters, the life of the packing, and its regenerability.

55975 Process design and economics of a Synthoil plant. Salmon, R.; Edwards, M.S.; Ulrich, W.C. (Oak Ridge Natl Lab, Tenn). *Coal Process. Technol.;* **4**: 59-66(1978).

A complete conceptual process design was prepared for a 100,000-bbl./day Synthoil facility charging 50,000 ton/day of Western Kentucky coal. This study covers that design and an economic evaluation based on the design. The facility had a nominal production capacity of 100,000 bbl./stream day at design throughput, and was located in the eastern interior region of the United States. The design feed is a coal with a sulfur content of 5.5 wt.-%. The product is a heavy fuel oil with a sulfur content of 0.4% to 0.6%. Net liquid production is 97,216 bbl./stream day. Total coal consumption is 50,133 ton/stream day, based on an as-received total moisture content of 9.2 wt.-% and an as-received higher heating value (HHV) of 10,445 Btu/lb. Coal consumption in the various parts of the facility is as follows (in ton/stream day): coal to Synthoil reaction section, 32,069; coal to hydrogen production, 11,894; and coal to steam and power production, 6,170.

55976 Filtering micron-sized particles from coal liquids. Rodgers, B.R. (Oak Ridge Natl Lab, Tenn). *Coal Process. Technol.;* **4**: 133-138(1978).

Process economics for filtration have been unfavorable, mainly due to low-flow rates but also due to contamination of collected solids with diatomaceous earth precoat and "body feed" (material added to a stream to be filtered). These high filtration costs make it necessary to either increase filtration rates and lower precoat costs or develop a more cost-effective alternative (e.g., agglomeration-sedimentation) before commercialization of coal liquefaction processes. Methods of achieving filtration rate and precoat cost improvements are discussed. It is shown that process economics are considerably improved by these techniques.

PYROLYSIS AND CRACKING

55977 (FE-MIT—2295T26-7) **Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1-September 30, 1978.** Bush, T.W.; Denholm, D.; Franklin, H.; Howard, J.B.; Peters, W.A.; Tejpar, Z.; Zacharias, M. (Massachusetts Inst. of Tech., Cambridge (USA)). Nov 1978. Contract EX-76-A-01-2295. 24p. Dep. NTIS, PC A02/MF A01.

A preliminary study of the disposition of parent sulfur and nitrogen among the gaseous, liquid and solid products of pyrolysis and hydropyrolysis of 45 to 53 μm Pittsburgh No. 8 bituminous coal was performed using the laminar entrained flow reactor. Experiments covered the temperature range 600 to 1000°C under helium and hydrogen at both 1 and 4 atm (abs) total pressure. Solids and volatiles residence times were around 0.5 s and heating rates are estimated to have exceeded 10^{40}C/s. Material, sulfur and nitrogen balances were measured. Some exploratory studies of the effect of particle diameter on coal pyrolysis and hydropyrolysis have been completed. As stated in the last progress report, time-temperature histories are not exactly reproducible on the captive sample apparatus in its current form. Thus when comparing product yields from coals of various mineral matter content, it is not always possible to obtain identical final temperatures in different runs. Thus by performing many runs smoothed curves covering the complete range of temperatures of interest were obtained, allowing base case temperature-yield curves to be established for demineralized coal. In the future, any run of any coal type may then be compared to the base case curve, regardless of whether there is base case data at precisely the temperature of that run. Other projects are described briefly. (LTN)

BY-PRODUCTS

55978 Pyrolysis of tetralin. Benjamin, B.M.; Hagaman, E.W.; Raaen, V.F.; Collins, C.J. (Oak Ridge Natl Lab, Tenn). *Fuel;* **58**: No. 5, 386-390(May 1979).

Experimental results are reported of a study of the pyrolysis of tetralin at 500°C. The pyrolysis products resulting from the decomposition were analyzed. Under the conditions employed, carbon scrambling is observed only in the aliphatic portion of the products. The primary mode of decomposition of tetralin proceeds via homolysis of the 1-8a bond. No equilibrium between tetralin and naphthalene plus hydrogen takes place in the absence of a catalyst.

55979 Ammonia from coal: an economic evaluation. Technical report No. 156. Katell, S. Morgantown, WV; West Virginia University (1978). 8p. (CONF-780611—16).

From AIChE symposium; Philadelphia, PA, USA (4 Jun 1978).

The availability of natural gas after World War II led to its use for almost all of the new ammonia plant installations subsequent to that period of time. Coal which had been the primary raw material soon lost its position in the field. At the present time there is every indication that a reversal will have to take place due to the shortage of natural gas. Two major changes have taken place since coal was the major feedstock in the industry. The first of these has been in the size of the plants--several 1000 ton-per-day single train operations now exist. The second has been major developments in coal gasification processes aimed at the production of synthetic fuels which now can be considered for the production of the synthesis gas required in ammonia production facilities. A plant designed to produce 1000 tons-per-day of ammonia using hydrogen produced by oxygen-coal gasification at 450 psig followed by 2-stage conversion, 2-stage purification, and methanation is estimated to require a capital investment of $105,127,000. The gasification operation is the entrained system developed by the Bureau of Mines during the period between 1955 and 1960. The methodology used in determining the capital investment is illustrated. The selling price for the product is determined in the given calculations. Based on the identified parameters, this price is indicated to be $119.77/ton.

PROPERTIES

REFER ALSO TO CITATION(S) 57108

55980 (ORNL/MIT—280) **Surface properties of NaOH treated coals.** Zimmer, M.F.; Kausch, W.J.; Marrero-Aldea, R.J. (Oak Ridge National Lab., TN (USA)). 19 Oct 1978. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

Surface properties of alkali-treated Illinois and Wyodak coals were studied using gravimetric, mass spectrometric, and calorimetric techniques. The results were compared with similar studies of untreated coals. The treatment increased H_2O sorption and the heats of immersion in water but reduced sorption of N_2 and CO_2. These observations were explained in terms of a flexible coal structure, the interstices of which may be closed by the NaOH treatment and may be accessible only by sorption of polar vapors. H_2O and CO_2 were the major species evolved in outgassing. Most of the H_2O was physically adsorbed, but some was liberated with CO_2 as the product of mineral decomposition.

55981 (PETC/TR—79/5) **Stability studies of coal liquids.** Brown, F.R.; Karn, F.S. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Aug 1979. 23p. Dep. NTIS, PC A02/MF A01.

The aging characteristics of liquid products derived from the hydrogenation of coal have been studied. Viscometric, spectrometric, ultimate analysis, solvent separations and oxygen consumption measurements have been employed to monitor the storage properties of the coal liquids under a variety of environmental conditions. Using viscosity measurements as the primary probe of changes in the stored samples, the rate of product degradation was found to be related to the initial viscosity of the sample, the storage temperature and the concentration of oxygen in the gaseous environment over the samples. Fractions of gross coal liquid samples obtained by solvent separation methods were monitored for their rates of oxygen consumption in order to more accurately determine those materials most susceptible to oxidation, and concurrent degradation of the product. The results of these studies show that coal liquids are very susceptible to oxidative degradation. This degradation can be conveniently monitored by noting changes in the viscosity of the samples with time. The more detailed analyses of aged samples show that the larger (on a molecular weight level) and more highly functional components are most susceptible to the oxidation process. Though the results indicate that the total coal liquid samples are more susceptible to oxidative degradation than petroleum-derived boiler feeds, removal of the most reactive components from the coal liquids to obtain a product more chemically similar to the petroleum products results in a fuel that has analogous stability characteristics.

55982 Pyrite in coal: a petrographic view. Grady, W.C. (West Virginia Univ., Morgantown). pp 1-4 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

Pyrite, the most common sulfur contributing mineral in coal, occurs predominantly as microscopic entities intimately combined with the coal. These entities are microscopic grains or aggregates of micron-size crystals. Grains smaller than 500 microns account for over 80% of the pyrite in the 29 coal samples examined. The effectiveness of coal cleaning processes for sulfur reduction depends in part upon the microscopic pyrite types present, and their size and distribution. Coal petrographic procedures are the only methods available to ascertain these pyrite-associated properties of a coal.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 55986, 55987, 56006, 56008, 56014

55983 (BNL—51040) **Regenerative process for desulfurization of high temperature combustion and fuel gases. Quarterly progress report No. 12, January 1-March 31, 1979.** Shen, M.S.; Albanese, A.S. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 25p. Dep. NTIS, PC A02/MF A01.

Portland cement, a calcium-based sorbent, was found to have a high sulfation reactivity. Spherical pellets, formed from powdered Portland cement by granulation, had exceptional higher resistance to attrition than natural limestone or dolomite, both of which had serious attrition losses in fluidized-bed reactors. The effect of carbon addition to Portland cement type III pellets on sulfation rates has been studied. A greater percentage of burnable carbon would leave more pores, and therefore increase the sulfation ability. An evaluation between sulfation reactivity and attrition resistance will be made to obtain the best combination. Experiments have been conducted on calcination and subsequent sulfation of calcium silicates and Greer limestone in a pressurized TGA. At 10 atm, calcium silicates sulfated better than limestone. A rotary kiln, 3" ID, has been completed and is now undergoing preliminary tests for temperature, feed rate and residence time. The effect of CO_2 concentation on the reductive decomposition of the sulfated sorbent has been investigated. Results of this study would provide the necessary information for an efficient design of sorbent regeneration processes. The mechanisms of the solid-solid reaction taking place in the regeneration: $2CaSO_4 + C \rightarrow 2CaO + 2SO_2 + CO_2$ are being studied. It has been shown that gaseous intermediates exist in the $CaSO_4$-C reaction, and are most likely supplied by the $CaSO_4$ decomposition.

55984 (FE—2408-9) **Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July-September 1978.** Li, K.; Rogan, F.H.; Yen, J.H.; Huang, C.S. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering). Oct 1978. Contract EX-76-C-01-2408. 53p. Dep. NTIS, PC A04/MF A01.

The new experimental system has been used for more than 80 runs. Isothermal rate data can now be obtained up to at least 850°C; above about 780°C, the data for all dolomites tested appear to follow the Avrami equation with n = 2. At 760°C, however, deviations from the Avrami equation are noted at low conversions, where accurate data could not be obtained in the old TGA system. As previously reported, sulfidation above about 780°C in H_2S/N_2 mixtures takes place in two steps: decomposition of $CaCO_3$ followed by sulfidation of the resulting CaO. A topochemical model has been developed for each step. The model for sulfidation also allows for the observed sulfidation of MgO. Weight changes predicted by these models agree satisfactorily with the data. Additional rate data have been collected for carbonation of sulfided dolomite. The previously reported rate decrease with increasing temperature has been confirmed, while flow rates appear not to affect conversion-time data. The first cyclic experiment has been completed through six cycles. Although the capacity declines with cycling, as is reported by others, the initial sulfidation and carbonation rates decrease only slightly. In the first four cycles, the decline in capacity resulted primarily from declining conversion in carbonation.

55985 (FE—2652-T4) **Prototype anthracite culm combustion boiler/heater unit: City of Wilkes-Barre, Pennsylvania. Quarterly technical report No. 3, April 1-June 30, 1979.** (Wilkes-Barre, City of, PA (USA)). 1979. Contract ET-78-C-01-2652. 20p. Dep. NTIS, PC A02/MF A01.

There are currently about 910 million cubic yards of anthracite culm (mine refuse) contained in 800 separate banks in a 480 square mile area in the Wilkes-Barre (W-B) anthracite mining region. Although this material represents a significant fuel value, equivalent

to approximately 1.25 billion barrels of fuel oil, the culm banks have accumulated because no satisfactory method of combusting this fuel was available until the relatively recent development of the atmospheric fluidized-bed (AFB) steam generator. A program was initiated in October 1978 to design, construct and evaluate a 100,000 ppH AFB steam generator burning anthracite culm with the addition of fresh anthracite, if required. The unit is to demonstrate the technical, economical and environmental feasibility of producing 150 psig saturated steam for district heating in downtown W-B. Phase I of the program consists of the design of the atmospheric fluidized-bed (AFB) plant and a hot model test program. Phase II of the program consists of construction, operation, testing and evaluation of the boiler and boiler plant.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55933, 55934, 55947, 55995, 56015, 57111

55986 (CONF-781253—1) **Environmental control technology: effluent survey of US strip mining sites.** Johnson, D.O.; Bogner, J.E.; Olsen, R.D. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

From Impact of the national energy act on utilities and industries due to conversion to coal meeting; Houston, TX, USA (4 Dec 1978).

This report outlines the program Environmental Control Technology Survey of Selected US Strip Mining Sites being performed at Argonne National Laboratory for the US Department of Energy. In addition, the report describes control technology efficiency for two mines in Pennsylvania and cost data for one of those mines. At the present time, mine drainage control and treatment at surface coal mines may not reflect conscientious planning and engineering design work by mine operators. On the whole, control technology (including reagent application) may be haphazard and periodically inefficient. Surface mine operators favor small, efficient, and above all, portable application systems for neutralization reagents. When choosing a reagent to neutralize mine drainage, reagent cost per unit quantity is less of a deciding factor to surface coal mine operators than ease of reagent application and handling. Costs for compliance with EPA/OSM effluent limitations can range from $3 to $7/ton. The higher costs are associated with steeply-sloped terrain.

55987 (CONF-7905106—1) **Groundwater contamination problems resulting from coal refuse disposal.** Schubert, J.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 29p. Dep. NTIS, PC A03/MF A01.

From 1. international mine drainage symposium; Denver, CO, USA (20 May 1979).

An inherent problem in the disposal of solid waste on land is the possibility of groundwater contamination by leachates from the waste. In the few studies conducted on the effects of coal refuse disposal on groundwater quality, significant impacts have been observed. Based on past and present rates of coal refuse disposal and current knowledge of water chemistry of runoff and seeps from refuse piles, significant groundwater contamination may be occurring in the eastern and midwestern United States. Following a review of previous studies and a discussion of water quality problems related to coal refuse disposal, results from a three-year investigation of an orphan disposal site in southwestern Illinois are discussed. Although the coal refuse lay unreclaimed at the site for over 50 years, contamination of groundwater from acid leachate extended less than 200 m from the gob pile in the underlying calcareous, silty-clay till. Reclamation of the site in 1977 did not have immediate effects upon groundwater quality, but long-term changes are likely to occur. Slightly increased infiltration into the gob pile is causing greater flows of acid seeps from the base of the pile, which may be hindering plant growth and increasing erosion of soil cover around the base. Further hydrologic and geochemical research is needed to assess the full magnitude of groundwater contamination problems related to coal refuse disposal at other sites and to develop disposal and reclamation criteria that are practical and effective in preserving long-term water quality at disposal sites.

55988 (N—79-13472) **Application of multispectral scanner data to the study of an abandoned surface coal mine.** Spisz, E.W. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Nov 1978. 80p. NTIS PC A05/MF A01.

The utility of aircraft multispectral scanner data for describing the land cover features of an abandoned contour-mined coal mine is considered. The data were obtained with an 11 band multispectral scanner at an altitude of 1.2 kilometers. Supervised, maximum-likelihood statistical classifications of the data were made to establish land-cover classes and also to describe in more detail the barren surface features as they may pertain to the reclamation or restoration of the area. The scanner data for the surface-water areas were studied to establish the variability and range of the spectral signatures. Both day and night thermal images of the area are presented. The results of the study show that a high degree of statistical separation can be obtained from the multispectral scanner data for the various land-cover features.

55989 (PNL—3104) **Assessment of environmental control technologies for Koppers-Totzek, Winkler, and Texaco coal gasification systems.** Mudge, L.K.; Sealock, L.J. Jr. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 94p. Dep. NTIS, PC A05/MF A01.

The US Department of Energy, Division of Environmental Control Technology, supports the Assistant Secretary for Environment in discharging responsibilities for environmental control aspects of technology in use and development. The coal gasification technologies employed by Winkler, Koppers-Totzek (K-T) and Texaco are described. Evaluation of the status of these technologies for control of major environmental pollutants indicates that a minimum risk to the environment is involved. The complete gasification process involves coal storage, coal preparation, gasification, gas cooling, particulate removal, acid gas cleanup, shift conversion, oxygen manufacture, cleanup of waste water and makeup water, and utility operation. The status of each of these technologies with respect to environmental acceptability is discussed. Very little is known about the behavior of trace elements in the K-T, Texaco and Winkler gasification systems. Airborne emissions of trace elements can occur from the utility boiler, and from wind entrainment of discharged residue and stored coal. Ash components are discharged from the gasification processes with gasifier residues and gas-cleanup sludges and residues. The trace element composition of coal is geochemically similar to the makeup of the earth's crust and includes almost all of the elements of the periodic table. The potential hazard from emissions of trace elements is mainly from long-term, low-level exposures to increased atmospheric pollution levels. Discharges from the K-T, Texaco and Winkler processes can be expected to have very minor contributions to atmospheric pollution levels of trace elements. Table 1 summarizes the status of technology and data needs for the different processing steps. The different process areas and their potential for intrusion of the environment are discussed.

RESERVES AND EXPLORATION

55990 **National Coal Resources Data System.** Stanton, R.W.; Carter, M.D. (Geological Survey, Reston, VA). pp 5-9 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

The U.S. Geological Survey implemented a computer-based National Coal Resources Data System. A two-phase development of the system will accommodate the availability and complexity of the data. Phase I (currently operational) contains published areal coal resources and chemical data which will serve the immediate general needs of the U.S.G.S. and the nation. Approximately 1500 U.S.G.S. detailed reports and maps and about an equal number of State Geological Survey and U.S. Bureau of Mines reports compose the coal-resource quantity estimates of Phase I. U.S. Bureau of Mines technical reports are the primary source for published chemical data. Phase I will enable questions to be answered much as in the past but far more rapidly and on the basis of data constantly updated with increasingly greater detail. Simple arithmetic functions can be applied to the data such as addition, subtraction, averaging, and standard deviation. Phase II (point-located data) consists of several hundred different variables recognized for each individual field or borehole observation. The input data are grouped into seven broad categories: physical, geologic, borehole, topographic, geochemical, geophysical, and petrographic. The physical data of Phase II include, among other items, seam thickness, location, identification, altitude relative to sea level, and extent and type of mining at the point location. Character and thickness of overburden, detailed coal-bed description, outcrop-line location, surface-slope angle, and cleat organization are included within the geologic and borehole files.

55991 **Resources of the Pittsburgh (No. 8) coal in the Belmont Field, Ohio.** Couchot, M.L. Columbus, OH; Ohio Division of Geological Survey (1978). 18p. (NP—23944).

The recoverable reserves of the Pittsburgh (No. 8) coal in the Belmont field have been determined to be 1,340,052,875 tons. Calculations were made on a degree-of-reliability basis and were made separately for coal with 100 feet or less of cover and for coal with greater than 1000 feet of cover. Mined and unmined areas were mapped on 7-1/2-minute topographic maps, and isopach and structure data for the Pittsburgh coal were added. Reliability categories were determined by distance from control points of measured coal thickness. A separate resource category was established for legal,

civil, or economic restrictions. Calculations were based upon planimeter measurement.

MINING

REFER ALSO TO CITATION(S) 55986, 55987, 56015

55992 (BM-RI—8365) **Slickenside occurrence in coal mine roof of the Valley Camp No. 3 mine near Wheeling, West Virginia.** Ellenberger, J.L. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Mining and Safety Research Center). 1979. 20p. Bureau of Mines, Washington, DC.

Slickensides are glossy, striated surfaces commonly found n the mine roof shales. Because slickensides have very little cohesive strength, they represent planes of weakness in the mine roof thereby contributing to roof failure, which may result in injuries or fatalities. Falls related to slickensides also require costly cleanup and result in production losses. The Bureau of Mines has investigated the occurrence of slickensides in mine roof in the Pittsburgh coalbed in a portion of the Valley Camp No. 3 mine in southwestern Pennsylvania to improve the potential for prediction of slickensided zones and determine the orientations of the most prominent slickensided planes. Two distinct types of slickensides were identified; those which were associated with clay veins observed in the coalbed (genetic), and those which were unrelated to any visible structure (nongenetic). The study draws three conclusions: (1) nongenetic slicksides are not the result of tectonic forces, (2) both genetic and nongenetic slickensides tend to dip at an angle of 30°, and (3) genetic slickensides tend to be aligned parallel to the trend of the clay vein and usually dip toward the center of the clay vein. A schematic roof bolting plan is presented that may provide improved roof support where slickensides are present. Roof stability could be improved by supplemental bolting in the direction normal to the plane of slickensides.

55993 **Directory of mining enterprises for 1977 and a section on the mineral industry of Montana in 1977. Bulletin 107.** Lawson, D.C. (comp.). Butte, MT; Montana College of Mineral Science and Technology (1978). 61p. (NP—23973).

Information requested from Montana mine operators and owners relating to mining activities is presented. Mining entrprises are listed systematically in categories in the main body of the Directory, either under Metal Mines or under Nonmetal Mines, Pits, and Quarries. In order, these categories are kind of ore or mineral produced; country in which the mine is situated; and the name of the mine. Additional information includes location of the property based on legal subdivisions of land survey; type of ore mined; mining district in which the property is situated; number of employees; mill capacity, if any; operator's name and address; owner's name and address; and yearly status, i.e., whether the property produced ore during the year, is still producing, developed ore without producing, or remained totally inactive. An index of mines, mine owners, and operators is included. The Directory also contains a list of presently inactive mines. Only those properties that have undergone development work or have produced ore within recent years but were inactive for a period of more than one year are included. Mines inactive for a period of three consecutive years are dropped entirely from the Directory. The rest of the Directory contains a list of Montana coal mines active in 1977 and a report entitled The Mineral Industry of Montana in 1977, by the Nonferrous Metals Division, Bureau of Mines, U.S. Department of the Interior, Washington, DC. (JGB)

55994 (INKA-Conf—78-345-001) **Five years of process control in the main road belt conveyor of the Haus Aden mine.** Weinheimer, O. (Bergbau A.G. Westfalen, Bergkamen-Oberaden (Germany, F.R.). Bergwerk Haus Aden). 1978. 51p. (In German). (CONF-7810197—1). Dep. NTIS (US Sales Only), PC A04/MF A01.

From Meeting on five years of process control in the main road belt conveyor of the Haue Aden mine; Bochum, F.R. Germany (12 Oct 1978).

After describing the development of the Haus Aden continuous crude coal conveyer system to interconnected conveyer operation and the necessity of a changeover to remote monitoring and control on an EDP basis, the strategy of process computer control of the Haus Aden main road belt conveyer is outlined. After a description of the process computer (including cost and economics considerations) and an outline of operating experience and operational safety of the process control system, a forecast is given further computer applications in bituminous coal mining.

55995 (ORO—4946-4) **Environmental aspects of coal production in the Appalachian region. Progress report, June 1, 1978-May 31, 1979.** Minear, R.A.; Overton, D.E.; Vaughan, G.L.; Tschantz, B.A. (Tennessee Univ., Knoxville (USA). Environment Center). 30 Mar 1979. Contract EY-76-S-05-4946. 483p. Dep. NTIS, PC A21/MF A01.

The overall project focus is on damage agent flow resulting from strip mining. The purpose of conducting the various activities simultaneously in four separate tasks is to fully identify the specific damage agents released during the mining process, quantify them, describe their origin and method of transport and to assess the effects of these agents: biological, chemical and physical. The common time and location of study for the individual research tasks allows an economy of data acquisition and exchange not possible through sequential task performance and, even more importantly with field research, all observations have a commonality of climatological, geological and physical variables. While restricted initially to field work in the mining areas of eastern Tennessee, models developed and phenomena observed are being tested for generalization and regional application as part of long-term project goals. Findings are reported for each of the individual research tasks below on work conducted to date. Collectively, the findings represent the range of distinct advancements, confirmation of expected behavior, definition of problem presence or absence, better definition of specific research direction, and in some cases, illumination of new directions that need to be pursued.

55996 (PB—289223) **Hydrologic characteristics of coal-mine spoils, southeastern Montana. Completion report.** Van Voast, W.A.; Hedges, R.B.; McDermott, J.J. (Montana State Univ., Bozeman (USA). Water Resources Research Center; Montana Coll. of Mineral Science and Technology, Butte (USA); Montana Bureau of Mines and Geology, Butte (USA)). Jun 1978. Contract DI-14-31-0001-4026. 39p. NTIS PC A03/MF A01.

Coal beds provide water as well as energy because of their generally fractured character. Hydraulic conductivities of saturated spoils are more diverse than those of the undisturbed coal beds but have comparable average values. Aquifer development in mine spoils is greatest near the bases of the spoils where coarse rubble and wasted coal accumulate. Median concentrations of dissolved solids (major constituents) and of some trace elements are higher in waters from mine spoils than in waters from coal beds. The potential for increased dissolved solids is considered the most significant.

55997 (PB—290192) **Advancement of mine ventilation network analysis from art to science. Volume I. Executive summary. Contract research report, 30 June 1973-30 June 1977.** Ramani, R.V.; Stefanko, R. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 15 Aug 1977. Contract H0133040. 33p. NTIS PC A03/MF A01.

This volume, the first of a six-volume final report, provides an executive summary of the research and results carried out under a contract from the Bureau of Mines on underground coal mine ventilation. Under the project, a mine ventilation simulator was developed. Sensitivity of leakage and friction factors on the total quantity and pressure requirements was studied. The simulator was applied to a new mine under development, and to an operating mine, to demonstrate the usefulness of the simulator in ventilation planning and in evaluating proposed changes to existing ventilation system.

55998 (PB—290193) **Advancement of mine ventilation network analysis from art to science. Volume II. Mine ventilation network theory. Contract research report, 30 June 1973-30 June 1977.** Didyk, M.; Ramani, R.V.; Stefanko, R.; Luxbacher, G.W. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 31 Mar 1977. Contract H0133040. 196p. NTIS PC A09/MF A01.

In this report the mathematical knowledge about mine ventilation network analysis has been reviewed and a mine ventilation simulation model that is to be used on a digital computer has been developed. The model includes most of the useful features of existing models such as mesh selection routines, fan characteristic curve fitting routines, and multiple fan network analysis with normal and fixed branches and natural ventilation pressures. Several other capabilities of the present model are: (1) Standardized input data, with options for the use of several resistance formulas, parallel or series branches, parallel or series fans, changes in air density or fan velocity, evases, etc. (2) A complete error test and message procedure. (3) An extensive report generator. (4) Network revision routines. (5) Multiple fan network analysis with the capability of handling gas or compressed air injections into the network and air volume expansions through dummy branches, imposed quantities through fixed quantity branches, directed ceiling quantities through Limit Quantity branches, leakages through Leakage branches that obey the general law $H = R \times Qm$, normal branches obeying Atkinson's law, and finally fan branches that simulate the effect of the pressure source. (6) Calculation of the gas concentration in each branch of the network. (7) Calculation of the absolute pressure at each node. The added features are well supported by the research done by the Bureau of Mines and other research centers.

55999 (PB—290194) **Advancement of mine ventilation network analysis from art to science. Volume III. User's manual for PSU/MVS. Contract research report, 30 June 1974-30 June 1977.** Didyk, M.; Ramani, R.V.; Stefanko, R.; Luxbacher, G.W. (Pennsylvania

State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Mar 1977. Contract H0133040. 86p. NTIS PC A05/MF A01.

In this report, the application of the Penn State Mine Ventilation Simulator (PSU/MVS) program is demonstrated through the use of a simple but realistic mine ventilation program. The report details, the problem description, the input data required, and the various output features of the simulator. The PSU/MVS program is written in Fortran IV for use with IBM 370/168 computers. A version of the program that can be used in CDC computers is also available. A ventilation network consisting of 531 branches, 300 nodes, and 5 fans took 48 seconds for solution on The Pennsylvania State University's IBM 370/168 computer.

56000 (PB—290195) **Advancement of mine ventilation network analysis from art to science. Volume IV. Sensitivity of leakage and friction factors. Contract research report, 30 June 1973-30 June 1977.** Ramani, R.V.; Stefanko, R.; Luxbacher, G.W. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Jun 1977. Contract H0133040. 117p. NTIS PC A06/MF A01.

In this report, the available information on friction factors and leakage characteristics are reviewed and summarized. The use of Penn State Mine Ventilation Simulator to analyze the sensitivity of the ventilation system to the changes in leakage and friction factors is discussed with examples. In simple ventilation systems, the results of changes in leakage and friction factors can be easily solved and explained by the laws of airflow. In complex systems, with fixed quantity branches and multiple sections, the effect of changes in leakage and friction factors cannot be generalized. This study points out the importance of good input data for obtaining reliable information from computer analyses and demonstrates the application of simulators to analyze the effectiveness of ventilation systems. An extensive bibliography on friction factors, leakage characteristics, and ventilation economics is included.

56001 (PB—290196) **Advancement of mine ventilation network analysis from art to science. Volume V. Application of PSU/MVS to the ventilation planning of a new mine. Contract research report, 30 June 1973-30 June 1977.** Stefanko, R.; Ramani, R.V.; White, R.J.; Luxbacher, G.W. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Jun 1977. Contract H0133040. 228p. NTIS PC A11/MF A01.

In this report, the use of Penn State Ventilation Simulator (PSU/MVS) for planning and evaluating new coal mine ventilation systems is demonstrated. The simulator's application to evaluate the ventilation system of a coal mine currently under development is discussed. The ventilation system is evaluated for representing development of the mine at the end of 12, 24, and 36 months after mining has begun. The report describes the necessary steps of data input preparation, ventilation network development, analysis of results, modifications to the network, and methods to expand the computer program for networks larger than 550 branches.

56002 (PB—290197) **Advancement of mine ventilation network analysis from art to science. Volume VI. Application of PSU/MVS to the analysis of modification to existing ventilation systems. Contract research report, 30 June 1973-30 June 1977.** Luxbacher, G.W.; Ramani, R.V.; Stefanko, R. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 31 Aug 1977. Contract H0133040. 459p. NTIS PC A20/MF A01.

This volume describes the use of the Penn State Mine Ventilation Simulator (PSU/MVS) to model existing mine ventilation systems and to evaluate the effect of system modifications. Ventilation survey methods designed to insure computer input data of sufficient accuracy for simulation purposes are covered in comprehensive detail, including quantity and pressure measurement and fan performance testing. The development of input data from ventilation survey results is discussed and illustrated by the use of an actual field survey. Two programs, written in Fortran IV with WATFIV, are presented to calculate airway head losses from altimeter pressure measurements. An existing coal mine ventilation system is analyzed and modifications to the system are simulated and evaluated. In addition, the application of the PSU/MVS to noncoal mines is briefly discussed. An extensive bibliography on ventilation surveying and simulation is included.

56003 **Back to the coal mines.** Howard, R. (Fluor Corp). *Combustion;* **50**: No. 10, 23-26(Apr 1979).

Large-scale surface coal mines--those producing 5 to 9 million tons or more of coal per year--will be the rule rather than the exception if the United States turns to liquefying and gasifying coal as a supplement for dwindling oil reserves. The typical mine of the future will equal or exceed the size of the largest mines operating today, and building it will require anywhere from millions to hundreds of millions of dollars. To evaluate the costs of building and operating such mines and the cost of the coal that will come out of them, the United States Energy Research and Development Administration, now part of the Department of Energy, commissioned Fluor Utah, Inc. to perform a study on the economics of large-scale surface coal mining. Highlights of this computer-based study are given.

56004 **Roof bolting patterns at three-way entry intersections.** Okubo, S.; Peng, S.S. Morgantown, WV; West Virginia University (May 1978). 36p. (NP—23983).

The problem considered is the analysis of a three-way mine entry intersection where entries intersect at right angles. A plane view of the right angle three-way intersection is shown. In the analysis entry widths were varied at 14, 20, and 26 ft. Pillars which consist of coal were assumed to be 40 feet wide. The idealized structural model of the region used in the finite element method is shown. The model consists of rock and coal which were assumed to be linearly elastic, homogeneous, and isotropic materials. Material properties used in the calculation are given. The coal seam of eight foot thickness was assumed to be 592 ft. below the surface. The model was divided into 512 three-dimensional hexahedron elements each of which has eight nodes and 24 translational degrees of freedom. The model thus contained 729 nodal points and 2187 degrees of freedom. The computer program NASTRAN developed by NASA was used throughout the analysis. The calculated results indicate that an arching zone is formed above a three-way intersection and a region of vertical tensile stress is developed over a short distance into the roof. The maximum tensile vertical stress and required shear resistance of a three way intersection are considerably larger than those of the four-way intersection of the same entry width. The tensile vertical stress and required shear resistance increases with decrease of angle of entry inclination. Thus the 30-degrees-inclined intersection is hardest to support among the cases examined. Suspension and reinforce methods of roof supports were studied. Preferable bolting systems for both methods are proposed.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 55954, 55957, 56013

56005 **Coal-oil mixtures: a good idea from DOE.** George, T.J.; Campbell, T.C.; Bergman, P.D. (US DOE, Process Eval Off, Morgantown, WVa). *Coal Min. Process;* **16**: No. 3, 68-70, 72(Mar 1979).

The use of coal-oil mixtures (COM)--an alternative fuel concept studied by two units of the Department of Energy (DOE)--is briefly explained and discussed here. If coal-oil mixtures were used in combustion units that now burn residual oil only, the demand for coal could be increased, and the residual oil requirements could be reduced substantially. Components and operation of a typical COM preparation plant are outlined, and both economic and marketing aspects of COM are considered.

56006 **Economics of coal preparation technology.** Peng, F.F.; Newcomb, R.T. (West Virginia Univ., Morgantown). pp 10-26 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

Despite their efficacy in desulfurization, coal preparation technologies have been largely neglected in research and development efforts to implement sulfur oxide control requirements. The paper describes both technical and economic reasons for this neglect, and shows why one can predict a much different role for mineral preparation technologies under the current techno-economic conditions that will determine fossil-fuel utilization and the implementation of existing standards. A regional analysis of coal characteristics and consumption combined with cost-engineering models of coal cleaning through level-three beneficiation are employed to establish the hypothesis that by 1990 almost all coal will be washed prior to combustion. Beneficiation-cum-scrubbing is forecast to be both the economic and technically optimum solution to fossil-fuel utilization in utility markets.

56007 **Multi-stream coal cleaning strategy.** McConnell, J.F. (GPU Service Corp., Parsippany, NJ). pp 31-47 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

A promising approach for the control of sulfur oxide pollution from coal-burning generating stations is the traditional practice of physical separation of pyritic sulfur from the coal prior to combustion. Technology is available with many coals to concentrate a high percentage of pyritic sulfur in the secondary or refuse stream from coal-cleaning plants. However, the generally limited sulfur reduction potential of cleaning at economically acceptable product yield rates has prevented widespread use of the technology for deep cleaning of so-called steam coals. Significant amounts of carbon are lost in the reject material, resulting from cleaning coal in a manner to

remove most of the pyritic sulfur. A potential solution to the problem of carbon loss is the preparation of multi-streams of cleaned coal whereby, through the use of a midling stream, the higher ash, higher sulfur, but useful coal fraction can be utilized in units permitted to burn it. Intensive physical cleaning of amendable coals in a Multi-Stream Coal Cleaning Strategy (MCCS) is a concept under consideration by the GPU System to control the emissions of sulfur oxides from coal-fired boilers. The concept is based on separation of raw coal into three component streams. The first stream consists of an intensively clean, high Btu, low-ash and low-sulfur product suitable for new units. The second stream is an intermediate sulfur and ash middling product suitable for use in existing units outside of critical air basins which are permitted to burn intermediate sulfur coal. The third stream is a refuse stream.

COMBUSTION

REFER ALSO TO CITATION(S) 55983, 55985, 56372, 57001

56008 (ANL/CEN/FE—79-5) **Support studies in fluidized-bed combustion. Quarterly report, January-March 1979.** Johnson, I.; Lee, S.H.D.; Shearer, J.A.; Smyk, E.B.; Swift, W.M.; Teats, F.G.; Turner, C.B.; Wilson, W.I.; Jonke, A.A. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 56p. Dep. NTIS, PC A04/MF A01.

This work supports the development studies for atmospheric and pressurized fluidized-bed coal combustion. Laboratory and process development studies are aimed at providing needed information on limestone utilization, control of emission of alkali metal compounds and SO_2, particulate loadings of flue gas, and other aspects of fluidized-bed coal combustion. This report presents information on: the removal of gaseous alkali metal compounds from hot flue gas using granular sorbents, results of tests of the efficiency of a commercial high-efficiency cyclone (TAN-JET), information on particulate emissions from FBCs, and the effect of $CaCl_2$ and Na_2CO_3 on the sulfation of limestone.

56009 (COO—4740-6) **Operation, modification, and maintenance of DOE/PETC 700 H.P. combustion test facility. Quarterly activity report, April 2-July 1, 1979, second quarter.** (Management and Technical Services Co., Clairton, PA (USA)). 1979. Contract EW-78-C-02-4740. 8p. Dep. NTIS, PC A02/MF A01.

The coal-oil mixture (COM) combustion test program of the 700 H.P. Combustion Test Facility has been performed successfully according to schedule. The parametric coal-oil mixture combustion tests with 30 and 40% coal concentrations were completed. Test data are being analyzed; some meaningful results were obtained. The combustor tests with 50% coal concentration have been initiated. The installation of the new 100 H.P., oil-fired, fire tube boiler for COM combustion studies is on schedule and facility shake down tests are scheduled.

56010 (FE—2694-T2) **Fuel extension by dispersion of clean coal in oil. Third quarterly report, June 1978-October 1978.** Burgess, L.E. (Gulf and Western Advanced Development and Engineering Center, Swarthmore, PA (USA)). 1978. Contract EF-77-C-01-2694. 99p. Dep. NTIS, PC A05/MF A01.

A new process concept shows merit. It offers lower cost processing with lower material costs, producing a cleaner more stable COM. The process uses tall oil to render raw crushed coal hydrophobic and oleophilic. The coal is simultaneously treated, cleaned, and dewatered. It is then mixed with oil. The COM produced has characteristics which show improved stability. The final part of the process converts the coal-oil mixture to a thixotropic gel, thereby assuring stability. Coal cleaned in the CLEANCOM process has significantly less ash content than that obtained in conventional cleaning. It is anticipated that the process can be used to extract coal from tailings or refuse piles. While the COM stability is currently based on No. 2 fuel oil, it is anticipated that the recently discovered difficulties with No. 6 fuel oil can be resolved by an investigation of the chemistry of this fuel and some practical research demonstrating gelation with this material. It was also demonstrated that: chemical grafting to coal does occur, as tested by the oleic acid titration; oleic acid and tall oil provide improved beneficiation by rendering the coal oleophilic/hydrophobic from a CG reaction; conversion oleic acid or tall oil provides a stable COM with sodium hydroxide, using No. 2 fuel oil; and No. 6 fuel oil shows a different COM stability effect using the fatty acid gelation approach. An open item is the determination of mechanisms of gelation formation in No. 6 and No 2 fuel oils.

56011 (FE—2694-T2, pp II.1-II.10) **Theory of gelling agents. Appendix II.** Fox, K.M. 1978.

In Fuel extension by dispersion of clean coal in oil. Third quarterly report, June 1978-October 1978.

COM fuel may be prepared by chemically grafting thickeners or gelling agents to the coal particles to help prevent settling. Gelling agents increase the viscosity of the blend as well as affecting the particle shape factor, thus inhibiting settling according to Stokes law. In situ processing is carried out by combining the fatty acid and fuel oil with heat and then saponifying the acid by neutralization with alkali. When saponification is complete, the soap/oil mix is cooled with stirring to control crystallization of the soap fibers and the viscosity of the finished mix. The object is to produce a COM fuel which gels below 150°F and flows at slightly higher temperatures. (LTN)

56012 (SAND—79-8729) **Effect of mineral matter and flame characteristics on the size of fly-ash produced from pulverized fuel combustion.** Pohl, J.H. (Sandia Labs., Livermore, CA (USA)). Sep 1979. Contract EY-76-C-04-0789. 7p. (CONF-790958—1). Dep. NTIS, PC A02/MF A01.

From 36. meeting of the pulverized fuel panel of the International Flame Research Foundation; Amsterdam, Netherlands (Sep 1979).

The particle size distribution of the fly-ash and the amount of mineral matter vaporized appear to depend on the original chemical and physical structure of the mineral matter in the coal as well as the flame conditions. The present knowledge of how these affect formation of fly-ash is reviewed, the physical distribution of mineral matter defined in a way more meaningful for combustion studies, and the extent of incomplete cenosphere formation discussed in light of data recently obtained in our laboratory. Unfortunately, a great deal more work is needed before even a qualitative mechanism of fly-ash formation can be accepted.

56013 **Sulfurtain process for pulverized combustion of high sulfur coals.** Buttermore, W.H. (West Virginia Univ., Morgantown). pp 27-29 of Proceedings of the coal processing and conversion symposium. Smith, C.J.; Nichols, D.G. (comps.). Morgantown, WV; West Virginia Geological and Economic Survey (1979).

From Coal processing and conversion symposium; Morgantown, WV, USA (1 Jun 1976).

A description of the Sulfurtain process is given including methods of pre-treating high sulfur or marginally unacceptable sulfur coals with limestone to decrease their sulfur polluting potential when burned. Methods for determining the quantity of limestone required and cost factors for limestone and alternative sorbents are discussed. The furnace used for laboratory testing is described, including methods used for analyzing the stack gases. Graphs comparing SO_2 levels resulting from the combustion of untreated coal and Sulfurtain-treated coal are included.

56014 **High temperature fluidization and limestone regeneration for fluid bed boilers.** Montagna, J.C.; Nunes, F.F.; Smith, G.W.; Vogel, G.J.; Jonke, A.A. (Argonne Natl Lab, Ill). *Coal Process. Technol.;* 4: 87-93(1978).

A process for regenerating SO_2-sorbents (limestone) for FBC boilers is being investigated. In the process, $CaSO_4$ in the sorbent is reductively decomposed in a fluid-bed reactor at 1 to 100°C. The fluid bed consists mostly of partially sulfated sorbent (600 to 2,000 μm) with some coal ash and unburned coal. Both the heat and reductants (CO, etc.) for the reactions are supplied by the partial combustion of coal. In the reducing environment and temperature of the regeneration reactor, the coal ash and sorbent soften and tend to adhere to each other. This causes a loss of fluidity in the bed, followed by local temperatures (> 1,100°C), low-melting calcium silicates and calcium-aluminum silicates form, and irreversible agglomeration occurs. Results show that the regeneration temperature and the total reducing gas concentration significantly affect the defluidization velocity, U/sub d/. An enhanced tendency to agglomeration at higher temperatures and greater reducing gas concentrations is in agreement with results by others for other particle systems.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 56003

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 55997, 55998, 55999, 56000, 56001, 56002

REGULATIONS

56015 (SAN—1619-T1) **Development plan for housing, public facilities and services.** (Mercer County Energy Development Board, Hazen, ND (USA)). Jul 1979. Contract ET-78-G-03-1619. 69p. Dep. NTIS, PC A04/MF A01.

The face of Mercer County will be changed radically over the next few years. Several energy supply projects and related mines have been initiated, and more are proposed. Currently, three companies mine lignite in the county. Much of this coal is used to supply the three coal-fired power plants already operating in Mercer county. However, coal production will have to expand in the next few years to supply five proposed coal-using plants. These will include the nations' first coal-gasification plant, which will be located northwest of Beulah, and four additional coal-fired power plants. When these projects become operational in the 1980's, the county's generating capacity will more than triple (to approximately 2,600 MW) and its coal production will almost quadruple. These energy projects will create what amounts to a population explosion in Mercer County. Recent estimates indicate that about 5,000 construction and operating workers will be employed in 1982. The resulting housing demand will double the housing stock in the County. During the early years of rapid growth, the communities will face serious deficit financing to provide expanded public services of all kinds.

PETROLEUM

REFER ALSO TO CITATION(S) 56782, 56783

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 57020

56016 (CONF-790805—P1, pp A.3.1-A.3.17) **Commercial scale demonstration of the Maraflood process: M-1 Project, Crawford County, Illinois (1978-1979).** Burdge, D.N. (Marathon Oil Co., Houston, TX). 1979.

From DOE symposium on enhanced oil and gas recovery and improved drilling technology; Tulsa, OK, USA (22 Aug 1979).

The contract with the Department of Energy for this 407 acre demonstration of the Maraflood oil recovery process was executed on September 30, 1976 after most of the development had been completed. Injection of micellar solution, manufactured at Marathon Oil Company's refinery, was initiated on February 10, 1977. A change in the micellar solution formulation necessitated by a chemical shortage was successfully accomplished in May 1978. Micellar solution injection was completed with this new formulation simultaneously in the 2.5- and 5.0-acre spacing areas of the Project in November 1978. A total of 10% pore volume of micellar solution was injected. The injection of the sequence of various mobility buffer concentrations has been proceeding since November without major problems. Injection rates for the mobility buffer have been increased over those used for the micellar solution. Fluid production is reported. Early evidence of an approaching oil bank is reviewed using the most recent available data and the results of performance monitoring over the past year are summarized. The initial results of economic monitoring are reviewed.

56017 (ORNL—5485, pp 81-94) **Enhanced oil recovery research.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Research discussed in this section includes work aimed at lowering the cost of chemicals used in micellar flooding; studying the phase behavior of aqueous-organic systems pertinent to this process; and studying basically the structure and properties of surfactant solutions. The pertinence to oil recovery is twofold: (1) equilibria involving alkali metals and alkaline earth ions affect the hardness of formation brines to which surfactants and some mobility-control polymers are sensitive, and (2) conditions under which adsorption is low of ions potentially useful as tracers for water flow need to be identified. 16 figures, 6 tables.

56018 (SAN—1395-35) **Pilot demonstration of enhanced oil recovery by micellar-polymer waterflooding. Phase C. Quarterly report for second quarter, 1979.** Staub, H.L. (Long Beach, City of, CA (USA)). 16 Jul 1979. Contract EF-77-C-03-1395. 21p. Dep. NTIS, PC A02/MF A01.

Initiation of the micellar slug injection has again been scheduled, after having been delayed since January due to unavailability of a hydrocarbon slug component. The diesel oil - one of the primary hydrocarbons required for formulating the micellar slug - has now been made available together with assurance of a continuing supply. Injection of the micellar slug should begin in early July. The micellar-polymer plant facilities have been checked-out. The existing sulfonate-Alfonic-hydrocarbon mix is being heating and circulated to ensure complete mixing preparatory to dilution with both the water and remaining Alfonic requirements. Marathon personnel will be present to supervise the blending of the initial batches of micellar slug for this application of the MARAFLOOD (TM) process and to demonstrate techniques for maintaining quality control.

56019 Wellbore pressure transducer. Shuck, L.Z. (to Dept. of Energy). US Patent 4,157,528. 5 Jun 1979. Filed date 8 Nov 1977. 6p. PAT-APPL-849,570.

Subterranean earth formations containing energy values are subjected to hydraulic fracturing procedures to enhance the recovery of the energy values. These fractures are induced in the earth formation by pumping liquid into the wellbore penetrating the earth formation until the pressure of the liquid is sufficient to fracture the earth formation adjacent to the wellbore. The present invention is directed to a transducer which is positionable within the wellbore to generate a signal indicative of the fracture initiation useful for providing a timing signal to equipment for seismic mapping of the fracture as it occurs and for providing a measurement of the pressure at which the fracture is initiated.

56020 Microwave method and apparatus for determination of adsorbed fluid in subsurface formations. Rau, R.N. (to Schlumberger Technology Corp.). US Patent 4,151,457. 24 Apr 1979. Filed date 31 Mar 1977. 16p.

An apparatus and method are described for determining the amount of adsorbed fluid in formations surrounding a borehole. Means are provided for deriving a first quantity which is a function of the dielectric constant of the formations as measured by passing electromagnetic energy of a first frequency through the formations. Means are also provided for deriving a second quantity which is a function of the dielectric constant of the formations as measured by passing electromagnetic energy of a second frequency through the formations. Finally, means are provided for determining the amount of adsorbed fluid in the formations as a function of the difference between the first and second quantities. In a preferred embodiment of the invention, the means for deriving the first and second quantities comprise means for transmitting microwave electromagnetic energy through the formations and measuring the relative phase shift and attenuation of the microwave electromagnetic energy in traversing the formations of interest.

56021 Sulfonation of crude oils to produce petroleum sulfonates. Plummer, M.A. (to Marathon Oil Co.). US Patent 4,147,638. 3 Apr 1979. Filed date 6 Jul 1976. 8p.

Petroleum sulfonates are obtained by treating whole crude oil or topped crude oil or mixtures thereof with sulfur trioxide, removing unreacted hydrocarbon, e.g., by addition of water, and neutralizing the sulfonic acids formed with a base, e.g., sodium or ammonia. The products have particular utility for the preparation of micellar systems for use in secondary-type petroleum recovery.

56022 Oil recovery by increasing the injectivity index of micellar systems containing crude oil sulfonates. Plummer, M.A.; Jones, S.C. (to Marathon Oil Co.). US Patent 4,147,637. 3 Apr 1979. Filed date 2 Sep 1977. 8p.

Flooding hydrocarbon-bearing, subterranean formations with micellar systems containing crude oil sulfonates is improved by extracting wax from the micellar system before it is injected into the formation.

56023 Pumping apparatus particularly for oil wells. Chardonneau, J.; Sable, C. (to Centre d'Exploitation et de Recherche Industrielle d'Application de Brevets (CERIAB)). US Patent 4,147,477. 3 Apr 1979. Filed date 22 Nov 1977. 6p.

A pumping apparatus is described that includes a pair of pumps which are joined by a flexible connection passing over spaced rotatable devices positioned for rotation in a substantially vertical plane. The rotatable devices are driven alternately in clockwise and counterclockwise directions whereby the lifting of one pump occurs as the other pump is lowered. To facilitate the pumping operation, a counterweight is operatively associated with the flexible connection intermediate the pair of rotatable devices.

56024 Use of nitrogen for improving the technological processes of oil recovey in the Ukrneft Association. Kachmar, Yu.D.; Lesovoi, G.A. *Nefteprom. Delo;* No. 4, 4-6(1978). (In Russian).

A description is given of operations undertaken in the Ukrneft association for improving the technology of borehole operations, acid treatment, thermal treatment and hydrosand-jet perforation with nitrogen. More than 200 wells were treated with nitrogen, 40 acid treatments with nitrogen, 37 thermal treatments and four hydrosand-jet perforations. Following the treatments of the facing zone, supplementary oil yield was increased by 2 to 3 times more than that achieved with methods earlier used. The economic benefits derived from the methods employing nitrogen for the years 1972 to 1976 came to about 800,000 rubles. 2 tables.

56025 Use of cement mortar with porosized coal for controlling sand formation. Charyev, O.M. *Nefteprom. Delo;* No. 4, 14-18(1978). (In Russian).

The most promising method for controlling sand debris is the strengthening of the facing zone with mixtures made of viscous solutions and effective fillers. In this connection, a study was made of new fillers that facilitate the formation of highly permeable rock in the facing zone. One of these materials was shown to be a porosized coal with a high granular fraction (0.63 to 5 mm and higher). It is a highly porous product that is produced by the thermal treatment of coal without access to air and subsequently subjected to heated steam. A technology was worked out for strengthening the facing zones of wells with sand manifestations on the basis of a mixture of cement mortar and porosized coal. 2 tables.

56026 Improving the properties of a foam system by adding a hydrocarbon solvent. Mamedov, T.M.; Tairov, N.D.; Kodzhanov, A.A.; Sarkosov, A.A. *Nefteprom. Delo;* No. 4, 18-20(1978). (In Russian).

Experimental-industrial tests were made at the oil and gas drilling section of the Ordchonikidzeneft association on extracting oil from depleted veins of the upper section of the Surakhan field by means of pumping a two-phase foam with hydrocarbon solvent additives into the bed. At first, a study was made of the effect that the hydrocarbon solvent additives had on the basic parameters of the two-phase foam - stability and its rheological properties. The foam's stability was studied by a method worked out by an All-Union scientific-research institute, by means of determining the separation time of 50% of the foam-forming liquid. An increase in the concentration of the hydrocarbon solvent of up to 15% of the foam-forming liquid's volume was shown to lead to an increase in the foam system's stability. A further increase in the solvent's concentration reduced the foam's stability. The rheological properties of two-phase foams with hydrocarbon solvent additives were studied on a capillary viscosimeter with a special device for foam formation. A two-phase foam with hydrocarbon solvent additives (up to 20%) was shown to be a viscoplastic, elastic system with a viscosity of 10 to 12 cP and a shear stress of 60 to 70 din/cm^3. Results are also given for studies on the intensity of the dissolving of a granular paraffin by a hydrocarbon solvent that is included into the foam system. The obtained results were used for the first time in regulating the process of air repression by pumping a two-phase foam with a hydrocarbon solvent additive into pressure well No. 609 where 5 wells were subjected to the treatment. The daily yield increased by 2 to 5 times a month after the foam system was pumped into the well. 3 figures, 1 table.

PROCESSING

56027 Apparatus for the thermal cracking of heavy hydrocarbon. Endo, T.; Sumida, Y.; Kawahara, T.; Ohtake, M.; Motokawa, S.; Nagayama, K.; Shigeta, M.; Hozuma, H.; Tomizawa, M.; Kikuchi, H. (to Kureha Kagaku Kogyo Kabushiki Kaisha). US Patent 4,147,753. 3 Apr 1979. Priority date 14 Oct 1975, Japan, 6p.

In a process for the thermal cracking of a heavy hydrocarbon in a cylindrical reactor, a portion of the content material in the reactor is taken out and injected back into the reactor according to a specific procedure to form a wet wall or liquid curtain on the inner peripheral wall of the reactor, thereby preventing coking in the reactor. The apparatus includes a radially outwardly extending interior annular recess around an upper portion of the inner wall thereof and forming a part of said inner wall and plural means for tangentially injecting the recycled liquid into said recess.

56028 Processing hydrocarbon feed of high carbon residue and high metals content. Nace, D.M. (to Mobil Oil Corp.). US Patent 4,147,617. 3 Apr 1979. Filed date 6 Apr 1978. 10p.

The fluid catalytic cracking of a residual oil fraction comprising metal contaminants and/or asphaltene type coke formers is processed by injecting the oil into the upper portion of a riser cracking operation under conditions to effect partial conversion thereof over a catalyst inactivated by carbonaceous deposits. A 650°F plus product of the low severity cracking is passed in contact with freshly regenerated catalyst under conditions of high conversion severity in the lower portion of the riser.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 56780, 56786, 56803

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 56030

ENVIRONMENTAL ASPECTS

56029 (AD-A—062028) **The Argo Merchant oil spill on-scene coordinator's report.** (Coast Guard, Boston, MA (USA). Marine Safety Office). Dec 1977. 129p. NTIS PC A07/MF A01.

This report factually documents the oil spill response action initiated by the United States Government following the grounding and subsequent foundering of the Liberian-registered tanker ARGO MERCHANT off the Northeast Coast of the United States at 0700 hours on December 15, 1976. This report covers the following factors associated with the pollution incident: Description of the cause and initial situation; Organization of response action and resources committed; Effectiveness of response and removal actions by The discharger, State and local forces, and Federal agencies and special forces; Unique problems encountered; and Recommendations on Means to prevent a reoccurrence, Improvement of response actions, and Changes needed to improve National or Regional Contingency Plans.

POLICY, LEGISLATION, AND REGULATION

56030 (EMD—79-78) **Economic and energy effects of alternative oil import policies.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 24 Jul 1979. 65p. General Accounting Office, Distribution Sect., Rm 1518, 441 G Street, NW, Washington, DC.

Report to the Congress of the United States by the Comptroller General.

This report examines alternative ways to reduce oil imports. GAO compared the economic and energy effects of continued price controls, price deregulation (including the administration's decontrol plan), import fees, domestic crude oil taxes and quotas. Overall, phased price deregulation appears to result in the best combination of costs and benefits for the Nation. It is the most effective at reducing oil imports by stimulating domestic production while avoiding the higher economic costs imposed by quotas. The administration's decontrol plan should lower imports, but will cause additional inflation over the next 3 years. GAO estimates the impacts of decontrol, on both oil imports and on inflation, will be higher than the administration suggests. The administration's proposed tax on windfall profits arising from deregulation of previously discovered oil will collect a small amount of revenue. The part of the tax on profits arising from future OPEC price increases, however, may collect considerably more revenue from the industry because the administration plans to establish a low base price from which profits are calculated.

TRANSPORT, PIPELINES, AND HANDLING

56031 Solution for transporting hydrocarbons in a pipeline. Flournoy, K.H.; Cardenas, R.L.; Carlin, J.T. (to Texaco Inc.). US Patent 4,152,290. 1 May 1979. Filed date 24 Aug 1977. 10p.

A method for transporting viscous hydrocarbons involves introducing into a pipeline or well-bore with the viscous hydrocarbons a solution containing (1) an anionic surfactant such as sodium tridecyl sulfate, sodium oleate, etc., or an oxyalkylated anionic surfactant of the sulfonate or sulfate type, and mixtures of the surfactants mentioned and (2) an alkalinity agent such as sodium hydroxide, thereby forming a low viscosity, salt-tolerant, oil-in-water emulsion. Optionally, the solution may contain a small amount of a guanidine salt or a water-soluble oxyalkylated, nitrogen-containing aromatic compound such as ethoxylated-8-hydroxy quinoline.

PROPERTIES

56032 Combinations of oil-soluble aliphatic copolymers with nitrogen derivatives of hydrocarbon substituted succinic acids are flow improvers for middle distillate fuel oils. Ilnyckyj, S. (to Exxon Research and Engineering Co.). US Patent 4,147,520. 3 Apr 1979. Filed date 16 Mar 1977. 12p.

Combinations of an oil-soluble aliphatic copolymer having the property of a nucleator for wax crystallization e.g., an ethylene-vinyl acetate copolymer having a number average molecular weight within the range of 500 to 50,000, in combination with an oil-soluble hydrocarbyl substituted succinic acid which has been reacted with a nitrogen material to form either an amine salt or an amide or a mixture thereof wherein the hydrocarbyl groups contain 8 to 28, preferably 12 to 22, carbon atoms are useful in improving the cold flow properties of distillate hydrocarbon oils. The flow improvers for middle distillate fuel oils described are combinations of an oil-soluble aliphatic copolymer and an oil-soluble hydrocarboyl substituted succinic acid. The aliphatic copolymer has the property of being a nucleator for wax crystallization e.g., an ethylene - vinyl

acetate copolymer having a number average molecular weight within the range of 500 to 50,000. the substituted succinic acid has been reacted with a nitrogen material to form either an amine salt or an amide or a mixture thereof. The hydrocarbyl groups on the succinic acid contain 8 to 28, preferably 12 to 22, carbon atoms. This combination of materials improves the cold flow properties of distillate hydrocarbon oils.

56033 Use of thermal springs of the 24th horizon in the Uzen Field to control sulfur reduction. Prasnikova, Z.F.; Bisekenova, S.M.; Dubovaya, E.A.; Mekhtieva, E.N.; Filatova, L.A. *Nefteprom. Delo;* No. 4, 6-9(1978). (In Russian).

A study was made of the effect that highly mineralized chlorine-calcium type thermal springs in the 24th horizon of the Uzen field have on the biogenic formation of hydrogen sulfide in oil deposits. The pumping of thermal water into the 7th pressure series was shown to lead to the practically complete suppression of biocenosis of sulfate-reduced bacteria (SRB) that had developed earlier as a result of pumping sea water. An increase in temperature of up to 60°C and mineralization up to 160 g/l adversely affected the growth of SRB cultures identified in the Uzen field. Sediments that are formed when various genetic types of water-marine and spring- are mixed were shown not to have a significant effect on the acceptance of a bed following the thermal spring treatment of SRB-contaminated sectors. 4 references, 4 tables.

COMBUSTION

REFER ALSO TO CITATION(S) 56009, 56010, 56011, 57001

56034 (STU—77-4427) **Disintegration of fuel oil with ultrasonics: a pilot study.** Haendel, S.; Klippberg, O. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Dec 1978. 5p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

Ultrasonics from a magnetostriction transmitter have been supplied to the mixture of oil and air in a burner head. Then the flame of the burner was more white which indicates that the flame temperature increased. Thus the efficiency of the combustion increased.

NATURAL GAS

REFER ALSO TO CITATION(S) 56783

GEOLOGY AND EXPLORATION

56035 (ORO—5202-T2) **Black shale studies in Kentucky. Quarterly report.** (Kentucky Geological Survey, Lexington (USA). Dept. of Geology). Mar 1979. Contract EY-76-C-05-5202. 86p. Dep. NTIS, PC A05/MF A01.

This document presents a compilation of geochemical data for the eastern Kentucky outcrop belt. It also reports on data collection activities for the EGSP (Eastern Gas Shales Project) data bank. (DLC)

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 56020

56036 (METC/CR—79/28) **Gas production of Devonian shale wells relative to photo lineament locations: a statistical analysis.** Howard, J.F.; Lahoda, S.J.; Zirk, W.E.; Komar, C.A. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center; West Virginia Univ., Morgantown (USA). Dept. of Statistics and Computer Science; Howard and Associates, Inc., Owensboro, KY (USA)). Apr 1979. 19p. Dep. NTIS, PC A02/MF A01.

A pilot study was made to relate Devonian shale gas well production to distance from photo lineaments that were mapped at two different scales, namely low altitude (1:24,000) and intermediate altitude (1:62,500). Cumulative production after 5 years for 41 wells located in the Vicco quadrangle of Perry Co., Kentucky, were used in the study. A statistical two-way analysis of variance design was used to group the data into four classes depending on whether the producing wells were within or beyond 300 feet of a photo lineament derived from both scales. Results indicate that cumulative 5-year production is higher for wells sited within 300 feet of a low-altitut photo lineament. The correlations evidenced in this study indicate a narrow zone of influence or effect for the geologic feature represented by the photo lineament. Moreover, the most consistently effective features are derived from low-altitude (1:24,000) scale photography, well below the detail most commonly utilized in studies to date.

56037 (METC/SP—79/8) **Unconventional gas recovery program. Semi-annual report for the period ending March 31, 1979.** Wise, R.L. (ed.). (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Aug 1979. 375p. Dep. NTIS, PC A16/MF A01.

This document is the second semi-annual report describing the technical progress of the US DOE projects directed at gas recovery from unconventional sources. Currently the program includes: Methane Recovery from Coalbeds Project, Eastern Gas Shales Project, Western Gas Sand Project, and Geopressured Aquifers Project. This report is divided into five parts: a summary (Section 1), and a section devoted to each resource (Sections 2 through 5). Each resource section presents information which serves as an introduction to that project.

56038 (ORO—5197-14) **Study of hydrocarbon - shale interaction. Progress report No. 14, April 1-June 30, 1979.** Schettler, P.D. Jr.; Wampler, D.L. (Juniata Coll., Huntingdon, PA (USA)). 1979. Contract EY-76-S-05-5197. 50p. Dep. NTIS, PC A03/MF A01.

Construction of an apparatus for degasibility/isotherm measurements up to 1000 psi is complete. Results of chromatographic analysis of off-gassing from wells KY No. 4-, PA No. 1-, PA No. 2-, OH No. 3-, and IL No. 4-EGSP are tabulated. Temperature coefficients of degasibility and isotherm parameters in Devonian shales were determined. A summary of degasibility/isotherm data is presented. A computer simulation of a matrix diffusion/fracture flow model in the radial case is discussed. A small infrared/x-ray diffraction study is proceeding on selected samples. (DLC)

56039 Gas well controller system. Norwood, W.L. US Patent 4,150,721. 24 Apr 1979. Filed date 11 Jan 1978. 24p.

A controller system for a flowing gas well is described that utilizes battery powered solid state production and cycle timeout circuitry. In addition to expanded cycle interval capabilities, the system permits a broad range of automated controls over well production through the continuous monitoring of and reaction to such parameters as casing pressure, tubing string pressure, plunger elevation, sales line pressure and flow rate, as well as liquid level monitoring within separation and storage facilities. The solid state circuitry incorporates such features as liquid crystal readout, battery voltage level monitoring and automatic reset at the commencement of each timing cycle. Motor valve actuation is provided by electromagnetic actuation of a controller mounted shuttle piston valve.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 56049

56040 (UCRL—82293(Rev.1)) **Chemical kinetics in LNG detonations.** Westbrook, C.K.; Haselman, L.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Sep 1979. Contract W-7405-ENG-48. 27p. (CONF-790828—1(Rev.1)). Dep. NTIS, PC A03/MF A01.

From 7. international colloquium on gas-dynamics of explosions and reactive systems; Gottingen, F.R. Germany (20 Aug 1979).

The problem of detonability of vaporized mixtures of liquified natural gas and air is addressed, using a characteristic time analysis. Separate numerical models are used to treat the evolution of the blast wave produced by a charge of high explosive and the chemical ignition delay of the fuel-air mixture. These models are combined with experimental data to predict the amount of high explosive required to initiate a detonation of a stoichiometric mixture of methane and air, giving an estimate of 50 to 100 kg of high explosive in spherical geometry. The effects of minor constituents such as ethane and propane on methane-air detonability are examined, and the mechanism by which these minor constituents kinetically sensitize the fuel is discussed.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 56764, 56787

56041 (NP—23925) **Potential natural gas supplies to California from the Texas intrastate market.** (California Energy Resources Conservation and Development Commission, Sacramento (USA)). Mar 1978. 38p. NTIS, PC A03/MF A01.

This appendix is divided into three parts: a study of Texas natural gas supply and demand, a critique of Part 1, and a legal memorandum on purchases of natural gas from the intrastate market for resale in California. (DLC)

ENVIRONMENTAL EFFECTS

56042 (UCID—17968-79-1) **Liquefied Energy Fuels Spill Effects Program. Quarterly report, January-March 1979.** Ermak, D.L. (comp.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

Four articles are included which report the progress and results of LLL research in the Liquefied Energy Fuels Spill Effects program. Separate abstracts were prepared for all four articles. (DLC)

56043 (UCID—17968-79-1, pp 1-10) **Average dispersion of a liquefied natural gas vapor plume.** Ermak, D.L.; Bowman, B.R. 1979.

In Liquefied Energy Fuels Spill Effects Program. Quarterly report, January-March 1979.

This paper describes the results of an ATMAS simulation of one China Lake spill experiment (AVOCET-2) and the use of this simulation to interpret the measured concentration data. Results show the need to make accurate wind velocity measurements. 6 figures. (DLC)

56044 (UCID—17968-79-1, pp 11-14) **Computer simulation of combustion and fluid dynamics in two and three dimensions.** Haselman, L.C.; Chase, J.B. 1979.

In Liquefied Energy Fuels Spill Effects Program. Quarterly report, January-March 1979.

Two computer codes were developed for two-dimensional (TDC) and three-dimensional (COM3) calculations in combustion and fluid dynamics. They can also be applied to pool fires, fireball formation/burn, and dispersion of LNG vapors. (DLC)

56045 (UCID—17968-79-1, pp 15-22) **Remote measurement of LNG vapor dispersion using LIDAR.** Multhauf, L.G.; Frank, A.M.; Koopman, R.P. 1979.

In Liquefied Energy Fuels Spill Effects Program. Quarterly report, January-March 1979.

The advantages and disadvantages of LIDAR are pointed out. Raman LIDAR was tested on a 5-m^3 spill at China Lake. Present plans for upcoming 40-m^3 China Lake spills with in-situ and LIDAR instrumentation are mentioned. (DLC)

56046 (UCID—17968-79-1, pp 23-42) **Small battery-powered infrared absorption sensor for methane, ethane, and other hydrocarbons.** Bingham, G.E.; Gillespie, C.H.; McQuaid, J.H. 1979.

In Liquefied Energy Fuels Spill Effects Program. Quarterly report, January-March 1979.

A portable, accurate gas sensor was developed for array deployment during LNG spill dispersion tests. The sensor is a direct evolution of the miniature portable CO_2 sensor. It is designed in two packages: a small, lightweight optical head assembly and an electronic control and processing unit, with no reference voltage in the connecting cable. (DLC)

56047 (UCID—18237) **Remote sensing for diagnosing vapor dispersion in spills of liquid energy fuels.** Multhauf, L.G.; Frank, A.M.; Koopman, R.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1979. Contract W-7405-ENG-48. 53p. Dep. NTIS, PC A04/MF A01.

The measurement of gas concentrations in Liquid Energy Fuel (LEF) dispersion clouds by remote LIDAR sensing is an attractive alternative to the use of in situ instruments in regions where the gas concentration level is low. A comparison of Raman and DIAL LIDAR has shown that Raman LIDAR is best suited to measure the concentration levels of interest in the LEF program. The LIDAR systems are limited primarily by the opaque fog produced by the evaporation of a cryogenic liquid fuel. The limitation is most severe for methane, for which LIDAR is not useful for concentrations above the flammability range. However, it is this low concentration region that the spatial extent of the cloud is large and not easily covered with an array. Comparison is made between a fence of in situ instruments proposed for 40-m^3 spills at China Lake (a row of 10 in situ instrument stations) and a Raman LIDAR system of similar cost designed to cover the same area of the cloud. LIDAR offers substantially higher spatial resolution and coverage that better allows for wind variations. A feasibility test of the Raman LIDAR instrument on a 5-m^3 spill at China Lake has demonstrated the usefulness of the technique. 23 figures, 5 tables.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 56037, 56040

POLICY, LEGISLATION, AND REGULATION

56048 **Natural gas demand, 1978-1995: forecast and technical documentation.** Sacramento, CA; California Energy Commission (1978). 377p. (NP—23977). California Energy Resources Conservation and Development Commission, 1111 Howe Avenue, Sacramento.

The California Energy Commission staff analysis of natural gas demand shows that annual statewide requirements of gas for non-utility users will actually decline a total of 1.5% by 1985 under normal weather conditions. This conclusion is based on a detailed, disaggregated analysis of residential, commercial, and industrial use of gas throughout California and represents a slowing of the approximately 20% decline in requirements which occurred from 1975 to 1977. Expected annual real gas price increases of over 5%, following the 15% increase in 1977, will impede future gas demand growth across all sectors of the economy. In addition, conservation measures already enacted by the California Energy Commission will reduce annual natural gas consumption by 9% by 1985 from the level it otherwise would have reached. These conservation measures will save enough natural gas annually to serve the equivalent of over a million households. Further conservation measures, such as retrofitting insulation, are expected to create significant additional savings. Although population growth and expanding use of gas appliances will increase gas demand, existing improved building, appliance efficiency, and intermittent ignition device standards are expected to hold residential sector consumption at its current share of slightly over 50% through 1985. Increased production efficiencies and switching from gas to other fuels will occur in the industrial sector, but by 1985 these gas-saving moves will be counterbalanced by 2% annual real growth in industrial output. In the commercial sector, the Energy Commission's existing building and appliance standards should hold consumption of gas to a constant level through 1985 despite population expansion and 2% annual per capita real income growth.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 56185

PROPERTIES

56049 (UCRL-Trans—11478) **Ignition behavior of natural-gas/air mixtures in free clouds.** Pfoertner, H. Translated from *Gas-Wasserfach, Gas-Erdgas;* **120**: No. 1, 19-24(1979). 24p. Dep. NTIS, PC A02/MF A01.

After discussing the ignition and explosion sequence in gas/air mixtures, the results of experimental investigations of detonating and deflagrating gas/air mixtures are reported. The results show that detonations can be precluded when natural gas is ignited by deflagrative means, even in large free clouds. Free gas clouds can be made to detonate - if at all - only by a strong detonative ignition. In a free deflagrating cloud, pressures higher than 0.1 bar can hardly be expected, even in regions of turbulence. However, analyses of large damage events indicate that partial confinement or special ground conditions may result in somewhat higher pressures.

56050 **High-explosive initiation of methane-air detonations.** Benedick, W.B. (Sandia Lab, Albuquerque, NM). *Combust. Flame;* **35**: No. 1, 89-93(May 1979).

The author recently reported results of some methane-air combustion experiments. In this article, this work is extended to include a preliminary study of the initiation of detonation in a stoichiometric methane-air mixture. Main interest lies in the "free-field" case, but some experiments involving confined mixtures were also conducted. Results indicate that a stable detonation can be propagated in a 2.4-m square column.

COMBUSTION

REFER ALSO TO CITATION(S) 56044, 56050, 56185, 57001

STORAGE

56051 **Storage of fuel gas.** Klass, D.L. (to Institute of Gas Technology). US Patent 4,147,456. 3 Apr 1979. Filed date 23 Feb 1978. 4p.

A method is provided for storing fuel gas by pumping the fuel gas into the lower portion of a storage vessel and automatically forming a solid fuel gas hydrate due to the vessel being positioned beneath the surface of a body of water and providing a lower zone

having higher pressure relative to the atmosphere, sufficient to cause solid hydrate formation of the fuel gas and water. The vessel extends vertically toward the surface of the water, and an upper zone having lower pressure, relative to the lower zone, sufficient to cause decomposition of the solid hydrate to fuel gas and water is provided. Fuel gas for the desired use is removed from the upper portion of the storage vessel. The method of this invention for storing fuel gas provides large, energy conserving, safe and low cost fuel storage areas beneath oceans and lakes, geographically close to the site of desired use.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 56788

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 56781, 56798, 56806

IN SITU METHODS, TRUE AND MODIFIED

56052 Determining the locus of a retorting zone in an oil shale retort by rate of shale oil production. Cha, C.Y.; Bartel, W.J. (to Occidental Oil Shale, Inc.). US Patent 4,150,722. 24 Apr 1979. Filed date 10 Mar 1978. 14p.

A retorting zone advances through a fragmented permeable mass of particles containing oil shale in an in situ oil shale retort in a subterranean formation containing oil shale. The fragmented mass comprises layers of formation particles of differing kerogen content corresponding to strata of differing kerogen content in the subterranean formation. The retorting zone advances in a direction substantially perpendicular to such layers in the fragmented mass. Kerogen in oil shale in the retorting zone is decomposed to produce gaseous and liquid products including shale oil, and shale oil is withdrawn from the fragmented mass. The rate of shale oil production in the retort depends upon the kerogen content of such a layer in such a fragmented mass through which the retorting zone advances. To determine the locus of the retorting zone with respect to such layers in the fragmented mass, formation is assayed for kerogen content for defining the locus of at least one such layer in the fragmented mass before retorting, and the rate of shale oil production from the retort is monitored. The locus of the combustion zone can be estimated from the locus of the retorting zone so determined.

56053 (UCRL—83348) **In situ oil shale retorts: coupling of heat and mass transfer.** Galloway, T.R.; Sandholtz, W.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 19p. (CONF-791108—5). Dep. NTIS, PC A02/MF A01.

From 72. AICHE meeting; San Francisco, CA, USA (25 Nov 1979).

The coupling between energy and mass transport has been used to develop a diagnostic method, Thermal Logging, which provides dispersion information and indications of the bed structural character in pilot scale retorts simulating in-situ oil shale rubble beds. This information as to the location and magnitude of flow nonuniformities permits real-time applications of process control techniques to maximize oil production. This paper examines the Thermal Logging process and how it responds to local variations in rubble bed permeability and thermal properties. An analytical relationship is proposed describing the propagation of the thermal logging front and the retorting front and results compared with experimental data from LLL 1/8 and 6 Mg pilot retorts.

56054 Ignition of fragmented oil shale below a sill pillar in an in situ oil shale retort. Ridley, R.D. (to Occidental Oil Shale, Inc.). US Patent 4,153,110. 8 May 1979. Filed date 13 Jun 1977. 12p.

An in situ oil shale retort is formed in a subterranean formation containing oil shale. The retort contains a fragmented permeable mass of particle containing oil shale. An open base of operation is excavated in the formation above the retort site, and an access drift is excavated to the bottom of the retort site. Formation is explosively expanded to form the fragmented mass in the retort between the access drift and an elevation spaced below the bottom of the base of operation, leaving a horizontal sill pillar of intact formation between the top of the retort and the bottom of the base of operation. The sill pillar has a vertical thickness sufficient to maintain a safe base of operation above the retort after the fragmented mass is formed. Prior to retorting, a particulate combustible material is placed in the blasting holes and ignited, and air is introduced to the ignited particulate combustible material to generate heated ignition gas for heating an upper portion of the fragmented mass below the sill pillar to a temperature greater than the spontaneous ignition temperature of carbonaceous materials in the oil shale. Heated organic carbonaceous material is then contacted with oxygen supplying gas to establish a combustion zone in the fragmented mass. The combustion zone is advanced downwardly through the fragmented mass to provide retorting of particles containing oil shale. Liquid and gaseous products of retorting are withdrawn from the fragmented mass.

56055 Method for in situ recovery of liquid and gaseous products from oil shale deposits. French, G.B. (to Occidental Oil Shale, Inc.). US Patent 4,147,388. 3 Apr 1979. Filed date 5 Jan 1978. 16p.

A tunnel is formed above an in situ oil shale retort in a subterranean deposit containing oil shale. A void is excavated in the retort site, and remaining deposit in the retort site is fragmented by explosively expanding toward the void to form a subterranean cavity containing a fragmented permeable mass of particles containing oil shale. The top of the fragmented mass is spaced downwardly from the tunnel to leave therebetween a pillar of unfragmented deposit. A retorting gas is introduced into the retort through a plurality of sloping passages from the tunnel for retorting oil shale in the fragmented mass. The liquid and gaseous products of such retorting are removed from the bottom of the retort. A portion of the carbonaceous products are used for generating electricity. In working a large area of deposit, a plurality of retorts are arranged in rows and columns. The tunnel is part of a tunnel system communicating with the tops of the retorts and having a peripheral double entry tunnel surrounding the rows and columns of retorts. Tunnel systems are also provided at a level adjacent the bottom of the retorts and at a level between the bottom and top.

SURFACE METHODS

REFER ALSO TO CITATION(S) 55927

56056 Separation of rock solids from heat carriers in an oil shale retorting process. Abdul-Rahman, Y.A.K.; Wolcott, H.B. Jr. (to Atlantic Richfield Co.). US Patent 4,152,245. 1 May 1979. Filed date 2 Dec 1977. 14p.

In an oil shale retorting process, hot heat-carrying solids are cycled to a retort zone to mix with and retort crushed oil shale, thereby producing gas, oil products, and a mixture of heat-carrier solids and spent shale solids. The spent shale solids contain some rock solids which have a heavier particle weight than the heat-carrier solids. The heat-carrier solids are separated and recovered from the spent shale for recycle through the process. In one stage of the separation procedure, a mixture of heat-carrier solids and rock solids is fed to a gas fluidized bed classifier which is constructed and operated in a way such that rock solids are preferentially separated from the heat-carrier solids. The separation stage is especially suited to spherically-shaped heat-carrier solids in a size range between about 0.14 centimeters (0.055 inch) and 1.27 centimeters (0.5 inch) and having a surface area of between 10 and 150 square meters per gram.

REFINING

REFER ALSO TO CITATION(S) 56027

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 56032, 56793, 56794

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 56789, 56791, 56792, 56795, 56797, 56804, 56805

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 57179

NUCLEAR FUELS

REFER ALSO TO CITATION(S) 56783

EXPLORATION

56057 (GJBX—133(79)) **Hydrogeochemical and stream sediment reconnaissance basic data for Hutchinson NTMS Quadrangle, Kansas.**

(Oak Ridge Gaseous Diffusion Plant, TN (USA)). 27 Jul 1979. Contract W-7405-ENG-26. 264p. (K/UR—128). Dep. NTIS, PC E06/MF E06.

Results of a reconnaissance geochemical survey of the Hutchinson Quadrangle, Kansas are reported. Field and laboratory data are presented for 592 groundwater and 616 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. The groundwater data indicate that the southwestern corner of the quadrangle offers some potential for uranium mineralization. Five large clusters of groundwaters with high uranium values occur here. Wells in the southwestern corner produce waters from the Permian Nippewalla Group and the overlying Kiowa Shale that often contain high concentrations of arsenic, molybdenum, selenium, and vanadium which are known to associate with uranium in sandstone deposits. The stream sediment data indicate that most of the uranium and thorium anomalies occur as placer-type concentrations associated with Quaternary deposits. There are three areas that show groups of high uranium and thorium concentrations in the stream sediments; one in the northeast in Chase, Lyon, Morris, and Wabaunsee Counties; one in Dickinson and Geary Counties; and the third, the large area west of long. 97° 20' W.

56058 (GJBX—142(79)) **NURE aerial gamma-ray and magnetic reconnaissance survey: NE Washington area, Okanogan NM 11-10, Sandpoint NM 11-11 Quadrangles. Volume I. Narrative report.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Aug 1979. Contract EY-76-C-13-1664. 148p. Dep. NTIS, PC E08/MF E08.

As part of the Department of Energy (DOE) National Uranium Resource Evaluation (NURE) Program, LKB Resources, Inc. has performed a rotary-wing, reconnaissance high sensitivity radiometric and magnetic survey in north-east Washington. Three 1:250,000 scale NTMS quadrangles (Spokane, Sandpoint, and Okanogan) were surveyed. A total of 14,421 line miles (23,203 kilometers) of data were collected utilizing a Sikorsky S58T helicopter. Traverse lines were flown in an east-west direction at 1.0 and 3.0 mile (1.6 and 4.8 kilometers) spacing, with tie lines flown in a north-south direction at 12 mile (20 kilometer) spacing. The data were digitally recorded at 1.0 second intervals. The NaI terrestrial detectors used in this survey had a total volume of 2,154 cubic inches. The magnetometer employed was a modified ASQ-10 fluxgate system. This report covers only the Okanogan and Sandpoint 1:250,000 scale NTMS quadrangles. Spokane 1:250,000 scale NTMS quadrangle is covered in a separate report. The radiometric data were normalized .o 400 feet terrain clearance. The data are presented in the form of computer listings on microfiche and as stacked profile plots. Profile plots are contained in Volume II of this report. A geologic interpretation of the radiometric and magnetic data is included as part of this report.

56059 (GJBX—142(79)(Vol.2)Okanogan) **NURE aerial gamma-ray and magnetic reconnaissance survey: NE Washington area, Okanogan NM 11-10 Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). May 1979. Contract EY-76-C-13-1664. 536p. Dep. NTIS, PC A23/MF A01.

The following data from the aerial gamma-ray and magnetic reconnaissance survey of the Okanogan NM 11-10 Quadrangle area in Washington are presented: geologic base map; flight path map, anomaly maps; radiometric multiple-parameter stacked profiles; magnetic and ancillary stacked profiles.

56060 (GJBX—142(79)(Vol.2)Sandpoint) **NURE aerial gamma-ray and magnetic reconnaissance survey: NE Washington area, Sandpoint NM 11-11 Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, PA (USA)). Aug 1979. Contract EY-76-C-13-1664. 378p. Dep. NTIS, PC A17/MF A01.

Data from the aerial gamma-ray and magnetic survey of the Sandpoint NM 11-11 Quadrangle in Washington include geologic base map, flight path map, anomaly maps, radiometric multiple-parameter stacked profiles, and magnetic and ancillary stacked profiles.

56061 (GJBX—143(49)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Durango Quadrangle (Colorado). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Aug 1979. Contract EY-76-C-13-1664. 121p. Dep. NTIS, PC E07/MF E07.

Between September 26 and November 9, 1978, Aero Service Division Western Geophysical Company of America conducted a high sensitivity airborne gamma-ray spectrometer and magnetometer survey over the 2° x 1° NTMS quadrangle of Durango, Colorado. The survey area is bounded by the 106°W and 108°W meridians and the 37°N and 38°N parallels. The area contains rocks of the Colorado Plateau suite in the southwestern part. The remainder of the area, with the exception of the eastern margin, is underlain by intrusive and extrusive igneous rocks and volcano-clastic sediments of Tertiary age. The eastern margin of the map is formed by the Quaternary alluvium of the San Juan Valley. The major river in the area is the Rio Grande, which drains the San Juan mountains to the east of the continental divide. The southwestern part of the San Juan mountains is drained by the San Juan river, a tributary of the Colorado River.

56062 (GJBX—143(79)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Durango Quadrangle (Colorado). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Jul 1979. Contract EY-76-C-13-1664. 191p. Dep. NTIS, PC A09/MF A01.

Results from the airborne gamma-ray spectrometer and magnetometer survey of Durango Quadrangle in Colorado are presented in the form of radiometric multiple-parameter stacked profiles, histograms, flight path map, and magnetic and ancillary stacked profile data.

56063 (GJBX—148(79)(Vol.1)) **Aerial radiometric and magnetic survey: Austin National Topographic Map, Texas Gulf Coast.** (Geodata International, Inc., Dallas, TX (USA)). 31 Aug 1979. Contract EY-76-C-13-1664. 174p. Dep. NTIS, PC A10/MF A01.

Results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Austin National Topographic Map NH14-6 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, .otal gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

56064 (GJBX—148(79)(Vol.2)) **Aerial radiometric and magnetic survey: Austin National Topographic Map, Texas Gulf Coast.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 182p. Dep. NTIS, PC A09/MF A01.

The results from an aerial radiometric and magnetic survey of the Austin National Topographic Map area of the Texas Gulf Coast are presented as multiple-parameter stacked profiles, magnetic stacked profiles, geology map, and flight base map.

MINING

56065 **Determination of uranium content in material.** Smith, R.C. (to Westinghouse Electric Corp.). US Patent 4,158,769. 19 Jun 1979. Filed date 20 Oct 1977. 10p.

The content of uranium, in a solution, as extracted from uranium ore by a solution mining technique for example, is determined by measuring the intensity of selected gamma or x radiation emitted by the solution. The gamma or x radiation is preferably derived from the thorium-234 daughter of uranium 238. The radiation from the solution impinges on a scintillator after being passed successively through K-edge filter foils of an alloy of ytterbium (e.g. with tin), an alloy of lutecium (e.g. with tin), and an alloy of hafnium (e.g. with zirconium). The resulting scintillation counts of the scintillator with the filter foils are arithmetically processed so that the scintillation derived from the thorium-234 63 KeV line is isolated. This scintillation is evaluated as a measure of the uranium content. To assure that the uranium thorium conversion has reached a stable state, the measurement should be made about three months after the uranium solution is produced.

FEED PROCESSING

56066 **Resolution of oil-in-water emulsions containing uranium.** Doft, R.H. (to Nalco Chemical Co.). US Patent 4,154,698. 15 May 1979. Filed date 8 Jun 1977. 6p.

A method of resolving oil-in-water emulsions resulting from the organic solvent extraction of uranium from aqueous acidic leach liquors which comprises treating the emulsions in accordance with the following steps: (a) adding to the emulsions a water-in-oil emulsion which contains from 2 to 50% by weight of a water-soluble acrylamide copolymer which contains from 5 to 50% by weight of a lower alkyl substituted tertiary aminoethyl methacrylate and quaternary ammonium salts thereof in an amount to provide at least 20 parts per million of the acrylamide copolymer; (b) adjusting the pH of the emulsion being treated with ammonia to at least 9; (c) adding to the ammonia treated emulsion a water-soluble surfactant which is capable of inverting the water-in-oil emulsion which contains the

polymer; and then (d) slowly mixing the treated oil-in-water emulsion for at least one-half hour to obtain good resolution thereof.

ENRICHMENT

56067 (K/OA—4175) **Cascade design considerations for cascades composed of stages with large separation factors.** Von Halle, E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Feb 1978. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

The unit cost of product from ideal and nonideal cascades are calculated and compared for a given separation task, that of producing reactor grade uranium containing 3.2% U-235 from normal feed containing 0.72% U-235, under the assumption that the total cascade costs are directly proportional to the total inter-stage flow of the cascade. For the examples chosen, in which the stage separation factors are in the range $2 < \alpha < 5$ and the resulting cascades contain from four to six stages, the desired product can be obtained at a lower unit cost from a nonideal cascade. However, the unit cost of product from the optimum nonideal cascade is only about one percent less than the unit cost of product from an ideal cascade. In general, this difference in the unit cost of product from nonideal and ideal cascades will be larger for larger values of the stage separation factors and fewer stages in the cascades than considered here; on the other hand, the difference will be smaller for smaller values of the stage separation factors and larger numbers of stages in the cascades, becoming negligible in the case of a close separation.

56068 (K/OA—4372) **Complementary value functions in binary isotopic separation and applications.** de la Garza, A. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 24 Sep 1979. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

Two functions analogous and complementary to the value function are discussed and applications of these functions are illustrated.

LASER EXCITATION

56069 (UCRL—15089) **Water-molten uranium hazard analysis. Final report. LATA report No. 92.** Hughes, P.S.; Rigdon, L.D.; Donham, B.J. (Los Alamos Technical Associates, Inc., NM (USA)). 21 Aug 1979. Contract W-7405-ENG-48. 111p. Dep. NTIS, PC A06/MF A01.

The hazard potential of cooling water leakage into the crucible of molten uranium in the MARS laser isotope separation experiment was investigated. A vapor-phase explosion is highly unlikely in any of the scenarios defined for MARS. For the operating basis accident, the gas pressure transient experienced by the vessel wall is 544 psia peak with a duration of 200 μs, and the peak hoop stress is about 20,000 psi in a 0.5-in. wall. Design and procedural recommendations are given for reducing the hazard. (DLC)

56070 **Method for separating gaseous mixtures of matter.** Schuster, E.; Kersting, A. (to Kraftwerk Union Aktiengesellschaft Muelheim). US Patent 4,158,614. 19 Jun 1979. Filed date 14 Apr 1977. 6p.

Molecules to be separated from a mixture of matter of a chemical component are excited in a manner known per se by narrow-band light sources, and a chemical reaction partner for reacting with these molecules is admixed while supplied with energy by electromagnetic radiation or heating, and as additionally required for making chemical reactions possible. A method is described for separating gaseous mixtures of matter by exciting the molecules to be separated with laser radiation and causing the excited species to react chemically with a reaction partner. It may be necessary to supply additional energy to the reaction partner to make the chemical reaction possible. The method is applicable to the separation of hydrogen isotopes by the bromination of normal methanol in a mixture normal methanol and deuterated methanol; of uranium isotope by the reactions of UF_6 with SF_4, $SiCl_4$, HCl, or SO_2; and of boron isotopes by the reaction of BH_3 with NH_3.

56071 **Isotope separation process.** Lyon, R.K. (to Exxon Research and Engineering Co.). US Patent 4,158,615. 19 Jun 1979. Filed date 11 May 1977. 8p.

A method is described for the isotopically selective excitation of gas phase molecules by multiple infrared photon absorption after which more of the excited molecules than nonexcited molecules are converted to a chemically different form which may be separated by means known in the art. This invention is useful for, but not limited to, the separation of the principal isotopes of uranium.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 56468, 56999

56072 (HEDL-SA—1592-S) **Remote fabrication of nuclear fuel pellets.** Nyman, D.H.; Dahl, R.E.; Claudson, T.T. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1978. Contract EY-76-C-14-2170. 5p. (CONF-7806157—1). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society conference; Washington, DC, USA (11 Jun 1978).

The equipment for remote fabrication of pellet fuels is in various stages of design, testing and evaluation. A pellet gaging system specifically designed to be maintained remotely has been demonstrated and is currently being interfaced with a programmable electro-mechanical manipulator to demonstrate completely automatic and remote disassembly and reassembly of the inspection unit. Pulsed magnetic welding of fuel rod end closures have been demonstrated. The solid-state welding technique allows the use of ultrasonics for weld inspection in place of traditional x-radiography. This welding and inspection method provides an attractive alternative for remote fuel fabrication. A new batch sintering furnace concept based upon aerospace technology is being developed. The furnace will have five to ten times the through-put of conventional batch furnaces and is easier to maintain than the horizontal furnaces in use today. Two high-speed mechanical press concepts (anvil and rotary) are currently being evaluated for remote operation and maintenance. The anvil press is especially attractive for remote fabrication due to its simplicity in set up and die change methods. All pellet fuel fabrication operations will be developed for remote operation and maintenance and representative fabrication rates will be demonstrated.

56073 (ORNL/TM—6906) **Sphere-cal process: fabrication of fuel pellets from gel microspheres.** Tiegs, S.M.; Haas, P.A.; Spence, R.D. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

The sphere-cal process uses gel-derived microspheres as feed material for fuel pellet fabrication. The basic sphere-cal process consists of microsphere gelation, drying, and calcining followed by pellet pressing and sintering. Each of these process steps were studied to try to determine the important parameters for the production of high quality UO_2, ThO_2, and $(Th,U)O_2$ fuel pellets. UO_2 sintered pellet densities increase both with decreasing calcination temperature (1000 to 600°C) and with decreasing forming pressure (414 to 138 MPa). Thermogravimetric analysis indicate that a minimum calcination temperature of 600°C is necessary for complete reduction of the UO_3 gel microspheres to UO_2. Batch screening suggests that use of minimum gel aging, fine-sized microspheres (50 to 400 μm), and fast drying (warm air or oven) will produce the highest quality UO_2 pellets. Thoria and thoria-urania microspheres produced by internal gelation or by external gelation (KFA method) were hard and compacted poorly, resulting in pellets with a remnant sphere structure. However, thoria-urania microspheres produced by the SNAM external gelation process were softer, resulting in more homogeneous pellets.

56074 (WCAP—9507) **Research and development program for selected components of mixed oxide fuel fabrication. Quarterly progress report for the period ending March 31, 1979.** Lyon, W.L. (comp.). (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Fuel Div.). 1979. Contract EN-77-C-06-1058-001. 65p. Dep. NTIS, PC A04/MF A01.

Currently authorized tasks are three of the original tasks and two added tasks: pneumatic powder transport system development, powder batch weighing, barrier seal development, remote MOX fabrication facility development, and expanded waste management studies. Technical progress on the active tasks is the subject of this report.

56075 (WCAP—9510) **Remote mixed oxide fabrication facility development. Volume 2. State-of-the-art review of remote maintenance system technology.** Horgos, R.M.; Masch, M.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Fuel Div.). Jun 1979. Contract EN-77-C-06-1058-001. 234p. Dep. NTIS, PC A11/MF A01.

This report provides a state-of-the-art review of remote systems technology, which includes manipulators, process connectors, vision systems and specialized process systems. A proposed mixed oxide fuel fabrication facility was reviewed and evaluated for identification of major remote maintenance and repair tasks. The technological areas were evaluated on the basis of their suitability or applicability for remote maintenance and repair of a proposed fully remote operating mixed oxide fuel fabrication facility. A technological base exists from which the design criteria for a reliable, remote operating facility can be established. Commercially available systems and components, along with those remote technologies now in development, will require modifications to adapt them to specific plant designs and requirements.

56076 (PNL-TR—369) **Process for preparing spherical particles of a metallic oxide or metallic carbide.** Hein, K.; Zimmer, E. Jul 1979.

Translation of . German(FRG) Patent Application 2,147,472. 14p. Dep. NTIS, PC A02/MF A01.

In this process, an aqueous solution of nitrate/chloride or a sol is dripped into a ketone phase over an aqueous ammonia solution. The ketone preferably is methyl isobutyl ketone, and methyl cellulose and/or polyvinyl alcohol are added to the solution or sol. Colloidal carbon is also added if a carbide is being prepared. (DLC)

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 56088, 56089, 56090, 56091, 56094, 56095, 56099, 56115, 56122, 56992

56077 (AED-Conf—78-258-001) **Research and development work in the Federal Republic of Germany on the reprocessing and waste treatment of LWR fuel elements. Achieved and planned.** Kroebel, R. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 17p. (In German). (CONF-780285—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From KTG seminar on the safety of reprocessing plants; Koeln, F.R. Germany (22 Feb 1978).

Since 1974 all state-promoted research and development work with the aim of building up a large waste disposal plant for irradiated nuclear fuels, are summarized in 'Project Reprocessing and Waste Treatment' (PWA). The lecture deals with the present state of planning and development. With consideration to the required safety standards, a series of process steps are being newly or further developed and are already being tested in test stands particularly for the part sections head-end end extract. tested as well as analytical methods and instrumentation for in-line process control being worked out. Further larger plants for component testing and process optimization are available for the years to come. The cooperation of the PWA in the research and development field is at an international level strongly influenced by the present international nuclear policy, nationally, the development is tested together with industry who are responsible for the building project of the large disposal plant.

56078 (CONF-790949—1) **Transuranium Processing Plant.** King, L.J.; Bigelow, J.E.; Collins, E.D. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Energy resources workshop; Oak Ridge, TN, USA (24 Sep 1979).

A brief description is given of TRU, which was built for recovering transuranium elements from irradiated HFIR targets. A Solvent Extraction Test Facility was installed in one cell. (DLC)

56079 (ISM—219) **Thermodynamic and experimental feasibility of decontaminating thorium-uranium fuels by a volatilization technique.** Carlson, O.N.; Chiotti, P.; Shiers, L. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 11p. (CONF-790962—1). Dep. NTIS, PC A02/MF A01.

From Conference on industrial use of thermochemical data; Surrey, UK (12 Sep 1979).

The thermodynamic feasibility of decontaminating a $(Th,U)O_2$ fuel by volatilization during conversion to the carbide and by subsequent electron beam melting was examined. Experiments on simulated fuels containing selected fission product element additions were perfomed and the results were generally in agreement with predicted behavior. The alkaline earth and rare earth elements were rather effectively removed, particularly from the substoichiometric monocarbide whereas zirconium, molybdenum and ruthenium were little affected.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 56086, 56131, 57018

56080 (KBS-TR—102) **Method for bending irradiated fuel rods.** Olsson, T. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Mar 1978. 36p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

ASEA-ATOM has performed a study including experiments which verifies that it is possible to bend, or rather to wind up irradiated fuel rods to a plane spiral with an outer diameter of about 300 mm. The fuel rods are inserted into stainless steel containers, each with room for two rods. In the container there is also a band of spring material along the side that will be subjected to tensions in the winding-up process. The container is sealed by welding and then winded up to form a plane spiral. It is described how the fuel rods can be packed and winded up in an industrial scale. Experiments have been performed which verify the proposed method.

56081 (PNL—3105) **Pacific Northwest Laboratory (PNL) spent fuel transportation and handling facility models.** Andrews, W.B.; Bower, J.C.; Burnett, R.A.; Engel, R.L.; Rolland, C.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 80p. Dep. NTIS, PC A05/MF A01.

A spent fuel logistics study was conducted in support of the US DOE program to develop facilities for preparing spent unreprocessed fuel from commercial LWRs for geological storage. Two computerized logistics models were developed. The first one was the site evaluation model. Two studies of spent fuel handling facility and spent fuel disposal facility siting were completed; the first postulates a single spent fuel handling facility located at any of six DOE laboratory sites, while the second study examined siting strategies with the spent fuel repository relative to the spent fuel handling facility. A second model to conduct storage/handling facility simulations was developed. (DLC)

56082 (SRO—1051-3) **Alternatives for water basin spent fuel storage using pin storage.** Viebrock, J.M.; Carlson, R.W. (Nuclear Assurance Corp., Atlanta, GA (USA)). Sep 1979. Contract EW-78-C-09-1051. 109p. (NAC-C—7917). Dep. NTIS, PC A06/MF A01.

The densest tolerable form for storing spent nuclear fuel is storage of only the fuel rods. This eliminates the space between the fuel rods and frees the hardware to be treated as non-fuel waste. The storage density can be as much as 1.07 MTU/ft² when racks are used that just satisfy the criticality and thermal limitations. One of the major advantages of pin storage is that it is compatible with existing racks; however, this reduces the storage density to 0.69 MTU/ft². Even this is a substantial increase over the 0.39 MTU/ft² that is achievable with current high capacity stainless steel racks which have been selected as the bases for comparison. Disassembly requires extensive operation on the fuel assembly to remove the upper end fitting and to extract the fuel rods from the assembly skeleton. These operations will be performed with the aid of an elevator to raise the assembly where each fuel rod is grappled. Lowering the elevator will free the fuel rod for transfer to the storage canister. A storage savings of $1510 per MTU can be realized if the pin storage concept is incorporated at a new away-from-reactor facility. The storage cost ranges from $3340 to $7820 per MTU of fuel stored with the lower cost applying to storage at an existing away-from-reactor storage facility and the higher cost applying to at-reactor storage.

56083 (SRO—1051-4) **Alternatives for water basin spent fuel storage using racked and unracked concepts.** Viebrock, J.M.; Eggers, P.E. (Nuclear Assurance Corp., Atlanta, GA (USA)). Sep 1979. Contract EW-78-C-09-1051. 178p. (NAC-C—7918). Dep. NTIS, PC A09/MF A01.

Spent fuel storage alternatives to conventional racking were: core plate storage, horizontal racks, stacked racks, and unracked storage. (1) The parameter that controls storage density in water basin spent fuel storage is the spacing between fuel assemblies. One method which will permit closer spacing and greater storage density is to position poison materials within and/or between fuel assemblies by inserting control rods in all positions in PWR assemblies or placing poison plates between BWR assemblies similar to the control scheme used in reactors. This core-plate concept offers little or no improvement over the conventional poisoned storage racks currently in use. (2) Another method is to stack the racks into two tiers, hence, a double rack. This concept is not feasible for a new away-from-reactor facility because of the design limitation of 30 feet for the storage pool depth. Evaluation of the nuclear, thermal, and structural aspects of nonpoison type stacked rack storage indicates a maximum storage density of 0.78 MTU/ft² for PWR fuel assemblies and 0.80 MTU/ft² for BWR fuel assemblies. These stacked rack storage densities are based on filling every hole in both levels of storage racks; storage densities comparable to poison-type vertical storage racks can be achieved by filling every other hole (checkerboard pattern) and by minimizing the distance between adjacent assemblies. (3) The storage density of horizontal storage racks is controlled by the height of the stacked horizontal storage cells. (4) The storage density of unracked horizontal storage is controlled by the distance between fuel assemblies and the number of rows or levels of storage.

56084 (SRO—1051-5) **Alternatives for water basin spent fuel storage: generic issues.** Viebrock, J.M.; Blackwood, M.J.; Genser, J.R.; Panter, H.R.; Ridihalgh, J.L.; Ward, J.R. (Nuclear Assurance Corp., Atlanta, GA (USA)). Sep 1979. Contract EW-78-C-09-1051. 138p. (NAC-C—7919). Dep. NTIS, PC A07/MF A01.

The need for fuel storage was examined and categorized storage concepts that provide increased density were categorized. During the categorization process it became apparent that several issues were common to all concepts, and they were separated from the rest for generic study: criticality, licensing considerations, materials and water chemistry. Section A documents the criticality analyses that were performed for both PWR and BWR fuel assemblies including the following parameters: enrichment, burnup, stainless steel thickness, Boral plate thickness, spacing between stainless steel canister and fuel assembly, and boron concentration in water. Re-

sults were used in the concept studies to identify acceptable storage rack design ranges and to provide a framework for the design optimization of spent fuel storage racks/canisters, in general. Section B deals with the licensing environment for spent fuel storage and goes into the past, present and future regulatory postures on both the state and federal levels. One of the limiting factors for storage density is the current set of criticality license criteria. It is recommended to have a unified set of criteria for away-from-reactor spent fuel storage which takes advantage of the inherent characteristics of both the fuel and the facility. Materials issues for long-term storage in a water basin system are evaluated in Section C for state-of-the-art and advanced concept storage methods. Section D deals with the water compatibility issues associated with spent nuclear fuel.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 56080

56085 (CEA-CONF—4190) **Solid and liquid radioactive wastes.** Cluchet, J.; Desroches, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Protection contre les Rayonnements). 1977. 42p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The problems raised by the solid and liquid radioactive wastes from the CEA nuclear centres are briefly exposed. The processing methods developed at the Saclay centre are described together with the methods for the wastes from nuclear power plants and reprocessing plants. The different storage techniques used at the La Hague centre are presented. The production of radioactive wastes by laboratories, hospitals and private industry is studied for the sealed sources and the various radioactive substances used in these plants. The cost of the radioactive wastes is analysed: processing, transport, long term storage.

56086 (KBS-TR—112) **Safety analysis of the encapsulation of irradiated fuel elements in copper containers.** Nordesjoe, E. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Mar 1978. 45p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the encapsulationsplant the irradiated fuel will be encapsulated in a copper container before delivery to the final underground waste disposal. In this report the process for encapsulation is described and an analysis of offsite radiological consequences both for yearly normal activity discharges and from unlikely accidents is performed. From the report it is concluded that the radiological effects will be very small, less than 10^{-4} mrem/year to surrounding people from normal operation. Even at extremely unlikely accidents, the individual doses will be negligably small. It is further concluded that the transport down to the final underground waste disposal can be performed in a safe manner. Even considering a total failure in the transport device down to the wastedisposal, significant damages on the capsul can be avoided with a special design of the transportshaft.

56087 (NUREG—0527) **Regulation of Federal radioactive waste activities. Report to Congress on extending the Nuclear Regulatory Commission's licensing or regulatory authority to Federal radioactive waste storage and disposal activities.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Sep 1979. 323p. NTIS.

The report contains two recommendations for extending the Commission's regulatory authority: (1) NRC licensing authority should be extended to cover all new DOE facilities for disposal of transuranic (TRU) waste and nondefense low-level waste. (2) A pilot program, focused on a few specific DOE waste management activities, should be established to test the feasibility of extending NRC regulatory authority on a consultative basis to DOE waste management activities not now covered by NRC's licensing authority or its extension as recommended in Recommendation 1.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 56101, 56145, 56970

56088 (AED-Conf—77-473-007) **Chemical processing of liquid effluents in reprocessing plants: experience gained in France.** Fernandez, N.; Pottier, P.; Taillard, D. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 13p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The radionuclides present in radioactive liquid effluents are precipitated for two purposes, viz: 1) to reduce the radioactivity to a level at which the liquids may be discharged; 2) to concentrate the radioactive compounds in the smaliest possible volume for storage. The scientific principles of the radionuclide precipitation process are reviewed in the first part, which covers the solubility product, adsorption onto the surface of the precipitates, co-precipitation by isomorphism, ion-exchange on precipitates, etc. The paper goes on to discuss flocculation techniques, flocculation monitoring (zeta potential etc.) and methods of separating the solid and liquid phases. The specific methods for precipitating the main radionuclides are then described, with special reference to Sr, Cs, Ru, Co and Sb. The synergism of certain methods of precipitation is also discussed. The main part of the paper concerns the application of chemical processes for purifying low and medium active effluents in the Marcoule and La Hague centres. Particular emphasis is placed on the development of the processes used and the improvement of performance. Lastly, the paper discusses the possibilities offered in final treatment in such a way as to determine the limits to the effectiveness of the chemical processes.

56089 (AED-Conf—77-473-016) **Method of assessing the effects of radioactive waste from the La Hague Centre.** Vilquin, A.; Le Grand, J.; Coulon, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service de Protection Sanitaire). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 20p. (In French). (CONF-771139—30). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Radioactive effluents from nuclear fuel reprocessing plants seminar; Karlsruhe, F.R. Germany (22 Nov 1977).

The plant for the processing of irradiated fuels at La Hague, which is particularly well-sited from the point of view of protection of the population, discharges effluent of a low radioactivity to the sea and to the atmosphere. A major programme of studies concerning the health aspects of this waste was undertaken well before the plant was built. The authors describe the various stages of that programme. Liquid effluent: 1) dispersion by measurement of currents and the release of tracers; 2) transfer of materials based on studies of physico-chemical and biological effects and sedimentology; 3) studies on the use of the environment (fishing, consumption of marine products). Gaseous effluent: 1) meteorological observations on site; 2) determination of annual average atmospheric concentrations; 3) assessment of ground deposition; 4) surveys of agricultural products, their distribution and consumption. Before the plant began operations, a highly refined monitoring programme was set up on the basis of these studies.

56090 (AED-Conf—77-473-024) **Design of the low-temperature rectification plant KRETA including the pre-purification units ADAMO and REDUKTION and first operating experience.** von Ammon, R.; Hutter, E.; Leichsenring, C.H.; Weinlaender, W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 6p. (In German). (CONF-771139—32). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Radioactive effluents from nuclear fuel reprocessing plants seminar; Karlsruhe, F.R. Germany (22 Nov 1977).

In the off-gas treatment system developed by the GfK Karlsruhe the noble gases Kr and Xe are removed by means of a low-temperature rectification process, in which the Kr-85 is largely separated from the inactive Xe. The Xe can then be released to the environment, while the radioactive Kr must be stored in steel cylinders. Prior to the above treatment the oxygen is removed to minimize ozone formation. This is effected, together with the removal of residual oxides of nitrogen, by catalytic reduction with hydrogen. At a subsequent stage of the pre-purification process all the gaseous components which could freeze out in the cryogenic section, i.e. H_2O, CO_2 and NH_3, and are removed by adsorption. These stages of the process are being investigated in the reduced-scale KRETA, REDUKTION and ADAMO pilot plants, which have a gas through-put of 50 m^3/h (at N.T.P.), using simulated inactive gas mixtures. The design of the three plants is described. The initial tests on the KRETA plant showed that an experimental decontamination factor of $>= 10^3$ could be achieved for the first column for rectification of the N_2-Kr-Xe system. Instances of xenon freezing out were also observed, these being accompanied by a drop in the decontamination factor. Separation of Kr from Xe in the second column proceeded smoothly with high enrichment of both components. Both the capacity and the efficiency of the ADAMO plant are very high for the separation of H_2O and CO_2. Coadsorbed Kr can be fully desorbed under normal conditions by flushing with N_2. Following preliminary laboratory tests for the REDUKTION plant a ruthenium catalyst has been selected, which is particularly insensitive to poisoning, e.g. by iodine.

56091 (AED-Conf—77-473-026) **Experience with pilot size iodine and krypton capture facilities under simulated conditions.** Goossens, W.R.A.; Collard, G.; Vaesen, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Pauluis, G.; Zahlen, A. (Societe Belge pour l'Industrie Nucleaire, Brussels). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 8p. (CONF-771139—31). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Radioactive effluents from nuclear fuel reprocessing plants seminar; Karlsruhe, F.R. Germany (22 Nov 1977).

The Belgian nuclear research center, SCK/CEN, some time ago constructed a nuclear gas purification mock-up with a nominal through-put of 25 m^3h^{-1}. The operational experience obtained in the iodine and krypton capture facilities of this mock-up is discussed. Elemental iodine and methyliodide traced with ^{131}I are removed from the gas stream by scrubbing with mercuric nitrate solutions and by adsorption on silver-containing sorbents. The scrubbing process is investigated in packed columns with internal diameters of 15 and 29 cm. The data analysis revealed that the mass transfer resistance is of necessity a function of both the gaseous and the liquid phase. Total iodine decontamination factors of the order of 10^3 are obtainable only by applying high circulation rates to the scrubber solution. Adding a column of silver sorbents in series to the mercuric scrubber guarantees an over-all decontamination factor of 4 x 10^3 for methyliodide. Krypton capture is studied under the special reprocessing condition whereby the xenon concentration is ten times greater than the krypton concentration. The noble gases are retained by liquid nitrogen refluxed at the condenser of a first packed column. The still content of this first column is transferred batchwise to a second packed column to separate krypton and xenon by batch distillation. In the experimental campaign krypton and xenon are removed from the carrier gas with a mean decontamination factor of 80 and 320 respectively. The xenon recovered is very pure while the krypton product contains a few tenths of one percent xenon.

56092 (AEEW-M—1631) **Treatment of active waste from a PIE facility.** Turier, C.A.; Kerswell, A.G. (UKAEA, Winfrith. Atomic Energy Establishment). Sep 1978. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The types of radioactive waste produced in the post irradiation examination of nuclear fuel elements from several classes of reactor are described. Other radioactive wastes may be produced in cave facilities as a result of contamination of the equipment. The methods of disposal of all types of waste are considered, together with methods to improve the operation of the caves. The training of cave operators, and the use of method study to collect information in cave operations are considered also.

56093 (DP-MS—79-40) **Operation of a prototype high-level alpha solid waste incinerator.** Hootman, H.E.; Trapp, D.J.; Warren, J.H.; Dworjanyn, L.O. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1979. Contract EY-76-C-09-0001. 19p. (CONF-791103—31). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A full-scale (5 kg waste/hour) controlled-air incinerator is presently being tested as part of a program to develop technology for incineration of Savannah River Plant solid transuranic wastes. This unit is designed specifically to incinerate relatively small quantities of solid combustible wastes that are contaminated up to 10^5 times the present nominal 10 nCi/g threshold value for such isotopes as ^{238}Pu, ^{239}Pu, ^{242}Cm and ^{252}Cf. Automatic feed preparation and incinerator operation and control have been incorporated into the design to simulate the future plant design which will minimize operator radiation exposure. Over 250 kg of nonradioactive wastes characteristic of plutonium finishing operations have been incinerated at throughputs exceeding 5 kg/hr for periods up to 6 hours. Safety and reliability were major design objectives. Upon completion of an initial experimental phase to determine process sensitivity and flexibility, the facility will be used to develop bases for the production unit's safety analysis report, technical standards, and operating procedures. An ultimate use of the experimental unit will be the testing of actual production unit components and the training of Savannah River Plant operating personnel.

56094 (ENICO—1005) **Description of the stack monitoring system and effluent measuring techniques at the Idaho Chemical Processing Plant.** Wong, M.A.; Roberts, R.S. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Aug 1979. Contract AC07-79ID01675. 39p. Dep. NTIS, PC A03/MF A01.

The stack monitoring system used to measure radioactive gas and particulate emissions from the Idaho Chemical Processing Plant is described in detail. The behavior of ^{129}I in the process off-gas and the particulate size distribution from the stack during different plant operations are evaluated. Recommendations for improvements to the system are presented.

56095 (ENICO—1011) **Technical and economic feasibility of zeolite encapsulation for krypton-85 storage.** Benedict, R.W.; Christensen, A.B.; Del Debbio, J.A.; Keller, J.H.; Knecht, D.A. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Sep 1979. Contract AC07-79ID01675. 96p. Dep. NTIS, PC A06/MF A01.

This report presents experimental results and analyses to demonstrate the technical and economic feasibility of encapsulation by zeolites as a method to immobilize krypton-85 for safe, long-term storage. The process, which is feasible for a reference 2000 metric ton of heavy metal per year reprocessing plant, would encapsulate krypton at approximately 20 cm^3/g, using temperatures greater than 575°C and pressures greater than 1600 atm. A conceptual design and cost estimate was made for a commercial-scale facility, using well-established technology for building, operating, and containing krypton-85 within such a processing system. Safety considerations to contain any krypton released from the processing equipment are within existing technology. 36 figures, 12 tables.

56096 (MLM—2646) **Mound cyclone incinerator preliminary design criteria: batch mode operation.** Klingler, L.M.; Alexander, B.M.; Todd, J.E. (Mound Facility, Miamisburg, OH (USA)). 28 Sep 1979. Contract EY-76-C-04-0053. 24p. Dep. NTIS, PC A02/MF A01.

A cyclone incinerator has been developed at Mound Facility for use in the disposal of radioactive wastes. Although simple in design and operation, the incinerator is capable of high quality combustion and excellent volume reduction. The use of the incinerator for Mound generated waste has demonstrated the effectiveness of the incinerator system. Design simplicity will aid in adapting the incinerator to a wide variety of applications.

56097 (PNCT—831-77-02, pp 46-48) **Solidification experiments of high-level liquid waste. I. Test operation of the fluidized-bed calciner.** Hoshino, Y.; Kubota, T.; Nagai, H.; Tsuzuki, S.; Katayama, H. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works). Sep 1977.

In Semi-annual progress report of Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, July-December 1976.

Many processes to solidify into glass, ceramics, or metal composites can be expected to solidify high-level liquid wastes, and the calcination is considered to be one of the steps in each process. A laboratory scale fluidized-bed calciner has been constructed to study the feasibility of the calcination process. The calcined products carried with off gas are caught by cyclones and collected in hoppers. The calcined products are also taken out from overflow line by changing the operating conditions. Off-gas leaving the cyclones is washed and cooled in the spray quench tower, then cooled again in the condenser, and released through the demister, filter and blower. The main purpose of this off-gas treatment system is to remove acid fume from off-gas. The calciner is made of stainless steel tube of 4 in diameter, and is designed to treat waste solution at the rate of 1.0 l/hr. Heating is carried out by means of an electroresistance heater up to 500 deg. C, and in-bed combustion of kerosene is performed at the temperature above 500 deg. C. The calciner was operated by using 5 N nitric acid instead of synthetic wastes. Ignition and combustion of kerosene were stable in the fluidized bed heated up to 650 deg. C. The temperature was able to be controlled within +-5 deg. C of the target by controlling the feeding rate of kerosene. There was no substantial trouble about the equipment in this test operation. But in case of very low feeding rate, the time lag in ignition and subsequent after-burning phenomenon were observed.

56098 **Process for treating waste water containing radioactive substances.** Kojima, K. (to Daicel Ltd.). US Patent 4,161,447. 17 Jul 1979. Priority date 13 Jun 1974, Japan, 6p.

A process for treating waste water containing radioactive substances comprising treating the waste water by reverse osmosis in the presence of at least one organic surfactant selected from the group consisting of anionic surfactants, cationic surfactants and nonionic surfactants.

56099 **Removal of plutonium and americium from alkaline waste solutions.** Schulz, W.W. (to Dept. of Energy). US Patent 4,156,646. 29 May 1979. Filed date 16 Jun 1978. 12p.

High salt content, alkaline waste solutions containing plutonium and americium are contacted with a sodium titanate compound to effect removal of the plutonium and americium from the alkaline waste solution onto the sodium titanate and provide an effluent having a radiation level of less than 10 nCi per gram alpha emitters.

56100 **Method for immobilizing radioactive iodine.** Babad, H. (to Dept. of Energy). US Patent Application 966,522. 4 Dec 1978. 8p.

Radioactive iodine, present as alkali metal iodides or iodates in an aqueous solution, is incorporated into an inert solid material for long-term storage by adding to the solution a stoichiometric amount with respect to the formation of a sodalite ($3M_2O$, $3Al_2O_3.6SiO_2.2MX$, where M = alkali metal; X = I^- or IO_3^-) of an alkali metal, alumina and silica, stirring the solution to form a homogeneous mixture, drying the mixture to form a powder, compacting and sintering the compacted powder at 1073 to 1373 K (800 to 1100°C) for a time sufficient to form sodalite.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 56077, 56095, 56129, 56130, 56131, 56132, 56133, 56134, 56135, 56136, 56137, 56138, 56140, 56141, 56142, 56143, 56944, 56951, 56955, 56990, 57117, 57199

56101 (AED-Conf—77-296-000, pp 37-44) **Treatment and final storage of radioactive waste in stable mountain formations.** Rydell, N.

(National Council for Radioactive Waste, Stockholm (Sweden)). 1977. (In German).

From VGB international congress on power stations; Copenhagen, Denmark (30 Aug 1977).

Data are given on radioactive hazard and decay heat of high level waste from nuclear fuel. The toxicity of the waste from one ton of spent nuclear fuel is compared with the toxicity of one ton of different non-radioactive heavy metals. The data on decay heat are used as background for considerations on waste solidification and disposal. Deposition of waste in crystalline rock is used as basis for a discussion of techniques and safety. The safety is based on the principle of multiple barriers. Four barriers can be defindet - the glass matrix, the metallic canister around the glass, the filling material between the canister and the rock, and the geologic formation. The requirements on these barriers are discussed. A sketch is given of a conceptual design of a depository, which is presently being studied in Sweden.

56102 (AED-Conf—77-470-002) **Duties of the Physikalisch-Technische Bundesanstalt (PTB) in connection with radioactive waste safeguarding and ultimate storage.** Roethemeyer, H. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 14p. (In German). (CONF-7710151—3). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Conference on the problems of radioactive wastes in nuclear technology; Essen, F.R. Germany (20 Oct 1977).

An outline of the history and duties of the Physikalisch-Technische Bundesanstalt (PTB) is to illustrate that the new duties of the PTB in connection with radioactive substance safeguarding and ultimate storage fit in very well with the range of duties of the PTB. The organisatory and technical accomplishment of these duties in cooperation with a building and operating company and with industry is explained. The department of the PTB for the 'safeguarding and ultimate storage of radioactive wastes' has an examining, appraising and licensing function in connection with construction, operation and shutdown of safety facilities. Methods for the safeguarding and ultimate storage of all the radioactive wastes in the Federal Republic of Germany are described.

56103 (AERE-R—9188) **Leaching of radioactive waste storage glasses.** Boult, K.A.; Dalton, J.T.; Hall, A.R.; Hough, A; Marples, J.A.C. (UKAEA, Harwell. Atomic Energy Research Establishment). Aug 1978. 40p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Results are reported of leach tests on various glass compositions proposed for the vitrification of the highly radioactive waste from the reprocessing of Magnox fuel. It is shown that the leach rate falls rapidly with temperature, decreasing by two orders of magnitude between 100 and 0°C. There is comparatively little difference between the leach rates in various natural waters but the Soxhlet apparatus gave values about three times higher than those found in static tests. Acidic solutions gave markedly increased leach rates: alkaline solutions also increased the leach rates under some conditions but to a lesser extent. Leach tests on plutonium containing glasses showed that this element was preferentially retained by the glass. The effect of α and β radiation on the leach rate was shown to be small.

56104 (GSF-T—84) **Research and development for the disposal of radioactive wastes. Annual progress report 1977.** (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Muenchen (Germany, F.R.). Inst. fuer Tieflagerung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle). Jun 1978. 72p. (In German). (KFK—2650; PWA—53/78). Dep. NTIS (US Sales Only), PC A05/MF A01.

The present report deals with the activities of the 'Entwicklungsgemeinschaft Tieflagerung'. This report presents a survey of the work performed in that field in 1977. The mining and construction work is discussed, which was carried out both underground and above at the Asse Salt Mine near Remlingen and which was done for repair, maintenance and expansion of operation in accordance with its future purpose. The experimental disposal of low-level wastes on the 750 m- and 725 m-level was continued in the time period under review. Only 7 drums of intermediate level waste were experimentally disposed of in 1977. The disposal field and the operational equipment for the single test disposal of spent fuel elements from the AVR-reactor were completed and are ready for operation. Due to juridical, political and transport problems there is a delay of the start of the test disposal. The mining of the prototype cavity was finished reaching a final depth of 996. 1 m. Moreover, the report gives information on means for radiation protection and the results of the environmental surveillance programme. Also the present status of the research activities and their results, especially in the field of disposal of high level waste, rock mechanics and safety studies is reported.

56105 (INIS-mf—4460) **Handling of spent nuclear fuel and final storage of vitrified high level reprocessing waste. 4. Safety analysis.** (Kaernbraenslesaekerhet, Stockholm (Sweden)). 1978. 115p. Dep. NTIS (US Sales Only), PC A07/MF A01.

The report is a safety analysis on the management of high-level radioactive waste from reprocessing of spent fuel. The work is part of the Swedish KBS-project. Handling, storage and transport will be done in accordance with international and national rules. Management and storing of vitrified high-level waste will be done according to the principals tested in the Marconle plant in France. The probability of the most severe accident, a ship collision with fire, is calculated to $3 \cdot 10^{-6}$ per year. If this will occur near a big city the maximal collective dose is about 30 000 manrem. This means that a maximum risk of 6 cases of radiation induced cancer occurs. For the most severe case concerning final disposal, a deep-well with drink water near the final storage, the individual dose is calculated to increase in the future by mostly 0.4 rem for 30 years, which will be reached after about 200 000 years. This is less than the variations of the natural radiation.

56106 (JAERI-M—7633) **Hydraulic pressure-resistance test of multi-stage type package of practical size for sea disposal.** Seki, S.; Ito, A.; Sato, M.; Takahashi, K.; Shinji, Y. (Japan Atomic Energy Research Inst., Tokyo). Apr 1978. 14p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

To evaluate the safety for sea disposal of low-level radioactive wastes, hydraulic pressure-resistance tests were carried out on multi-stage type packages of practical size under the condition simulating 6000m deep sea, i.e., hydraulic pressure 600 kg/cm^2 and pressure increasing rate 1 kg/cm^2/sec. In the course of increasing pressure, ingress of sea water occurred through leak paths incorporated in advance so that the inside pressure was equalized with the outside pressure. As a result, no appreciable damages of the packages that would give rise to controversy in safety were observed.

56107 (KBS-TR—12) **Judgement of properties and function of concrete in connection with final disposal of nuclear fuel wastes in rock.** Bergstroem, S.G.; Fagerlund, G.; Romben, L. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1977. 162p. (In Swedish). Dep. NTIS (US Sales Only), PC A09/MF A01.

This report deals with the possibility of using concrete in conjuction with the permanent storage of nuclear fuel waste in rock storage facilities. The emphasis has been placed on properties such as strength and tightness and how these may be affected by internal and external causes of destruction during a filling stage of approximately 100 years and during the final storage stage of 1 000 - 100 000 years. It is established that spontaneous structural changes, which lead to a certain increase in porosity, cannot be precluded during the filling stage and uring the final storage stage. It is deemed possible to avoid cracking during the manufacture and during the filling stage if the concrete is kept moist. The risk for cracking during the final storage stage is difficult to assess. Attempts are made to estimate the tightness of aged concrete during the various stages. The tightness during the final storage stage is difficult to assess due to the fact that the scope of the cracking cannot be estimated. Chemical attacks during the filling stage are deemed to be small and can be repaired. The risk for destruction due to radioactive radiation is extremely small. Reinforcement, if any, can be protected during the filling stage on condition that the concrete is kep saturated but all reinforcement will be destroyed during the final storage stage. By way of conclusion, a number of general views on the choice of concrete and work methods are provided.

56108 (KBS-TR—81) **Manufacturing method for copper capsules used for final disposal of spent nuclear fuel.** Bergstroem, J.; Gillander, L.; Hannerz, K.; Karlsson, L.; Loennerberg, B.; Nilsson, G.; Olsson, S.; Sehlstedt, S. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 23p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

This report describes the manufacturing method for the copper capsule, which is proposed by KBS for final disposal of spent nuclear fuel. The design and the dimensioning with respect to stress calculation is shortly explained. Alternative casting and forging methods are discussed and compared. The preferred method is conventional static casting and upsetting and strech forging of the block in order to obtain a fine granular structure. Available equipment in the steel industry are considered useful for those operations. The machining of the capsule consists of turning and long hole drilling, which can be performed by available equipment in Swedish workshop industry. Non-destructive tests can be made with ultrasonic technics as the capsule has a fine granular structure. Inserting of fuel and filling with melted lead into the capsule are non-conventional processes, which are based on the experience from fuel handling in nuclear plants and on lead pouring in other industrial applications. Special lead pouring tests have also been made for this particular purpose. The welding of lids is made by electron beam welding. Welding tests has been made with good result. The weld depth is on the limit of what is possible with the present Swedish equipment, but this field is being developed very quickly and welding equipment

with higher capacity is already available which will simplify this operation. The ultrasonic test of the welds has been experimentally checked and does not involve any particular problems.

56109 (KBS-TR—82) **Handling and final storage of radioactive metal components.** Loennerberg, B.; Engelbrektson, A.; Neretnieks, I. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 37p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

After the dismounting of the fuel elements, the next stage is to undertake the final storing of the metal components, which have kept the fuel rods together. The components are transmitted to a pool where they are cut into pieces, compacted and placed in wire baskets. These are transferred in a water channel to a cell, where the metal components are embedded into concrete blocks. Thus the baskets are placed in prefabricated concrete containers, after which the metal parts are embedded into cement grout, injected from the bottom of the containers. The blocks are finally stored in rock tunnels constituting a storage similar to the repositories for vitrified waste and spent fuel, although somewhat simplified, taking advantage of the much lower amount of radioactive material in the case of metal components. Thus a depositioning depth of 300 m in rock is very much on the safe side and it is appropriate in this case to fill the tunnels with concrete, ensuring by its alcalinity a suffi ciently low rate of dissolution of the metal and migration of radioactive substances.

56110 (KBS-TR—83) **Handling of canisters with spent fuel in the final repository.** Engelbrektsson, A. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Apr 1978. 27p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

accordance with the project for the final storage of nonreprocessed spent nuclear fuel, the waste will be encapsulated into copper canisters which will be deposited in a final repository located in rock 500 m below ground level. The canisters will be placed in vertical holes in the bottom of the tunnels, where the copper cylinders will be surrounded by blocks of highly compacted bentonite. The purpose of this report is to describe the transport of the fuel canisters from the encapsulation plant above ground level and the handling of the canisisters until they are finally placed in their depositioning holes. The design of the transport system is based upon the basic principles that a complete radiation protection shall be provided during normal operations in the tunnels and that no radioactive emission or radiation protection problems should arise in consequence of transport accidents etc. Possible accident situations have been analysed.

56111 (KBS-TR—93) **Preliminary corrosion studies of glass ceramic code 9617 and a sealing frit for nuclear waste canisters.** Sundquist, I.D. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Mar 1978. 52p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A study was initiated to evaluate glass-ceramic Code 9617 and a sealing frit (glass Code 186AYU) to determine the suitability of these materials for use in the construction of a cannister to contain and permanently isolate spent nuclear fuel rods. The granite repository storage conditions included ground water in contact with bentonite clay plus sand with temperature cooling from 100 to 40 deg C in 500 years. The water exchange rate is 1 ml per cm^2 of cannister surface per year. Tests were conducted at 60, 90, 130, and 180 deg C. Most of this preliminary work was done with distilled water with a few tests in water containing bentonite and sand or salt. Preliminary data suggest that the glass-ceramic would lose about 0.1 cm of thickness in the first 1000 years of storage. There is little evidence to suggest that the corrosion rate in ground water/bentonite/sand mix or in salt water would differ by more than an order of magnitude. It appears that the spodumene fraction of the glass-ceramic is very corrosion resistant, even at 1800 deg C. This suggests that modifications in bulk composition or processing could dramatically decrease overall corrosion rates.

56112 (KBS-TR—96) **Corrosion testing of unalloyed titanium in simulated disposal environments for reprocessed nuclear waste.** Henrikson, S.; de Pourbaix, M. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Apr 1978. 48p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

On the commission of the Nuclear Safety Project (KBS) corrosion tests have been carried out on unalloyed titanium, which is planned to be used as an outer corrosion resistant canister for reprocessed nuclear waste. The corrosive medium was modified Baltic water at 100 and 130 deg C with either a high (8 ppm) or a low (>10 ppb) oxygen content. The total duration of the tests was 300 days. Very low oxidation rates (<0.1 micron/year) were obtained, corresponding to a life time of ten thousands of years for a 6 mm thick titanium canister. In spite of the considerably accelerated corrosive conditions, compared with those estimated for the final disposal, no signs of localized corrosion were found, nor could any hydrogen pick-up be detected.

56113 (KBS-TR—99) **Leaching of active French glasses at Studsvik: progress report 1978-06-01.** Blomqvist, G. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 61p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

The leaching of highly active French glasses at Studsvik, which have been described earlier, have continued. This report gives analytical data up to 1978-04-03. LWR glasses containing Cs and Sr show considerable difference in the beginning which tend to diminish during stage 5. Observed leach rates are 1-2 x 10^{-6} g cm^{-2} day^{-1} at the end of observations. They have a tendency to decrease futher. Increase in temperature from 25 deg C to 60 deg C gave a leach rate increase with a factor of about 10. In all cases but one the leach rate at 60 deg C decreased considerabley with time. For Pu, the leach rate remained approximately constant at 5 x 10^{-7} g cm^{-2} day^{-1} during stages 1 - 3 and beginning of stage 5. After a few weeks of that stage there was a temporary strong increased of Pu leaching, that decayed back to about 5 x 10^{-6} g cm^{-2} day after about a month. This effect is still unexplainded but may be due to inhomogenity.

56114 (KBS-TR—104) **Finite element analysis of a bentonite-filled rock cavity.** Stephansson, O.; Maeki, K.; Groth, T.; Jonasson, P. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Sep 1978. 74p. (In Swedish). Dep. NTIS (US Sales Only), PC A05/MF A01.

This study presents the results of a finite element analysis of the stability of a storage hole filled with compacted bentonite and a storage tunnel filled with a bentonite-sand mixture for a final repository of radioactive waste. The bentonite has swelling properties and the swelling pressure causes additional loading on the wall of the storage hole and tunnel. In this analysis we assume a swelling pressure of 10 MPa for the storage hole with the diameter of 1.5 m and 0.5 MPa for the storage tunnel with the width of 3.7 m and the highth of 4 m. Results of the FEM-analysis at plane strain show stress concentrations in the roof of the tunnel and below the bottom of the storage hole. While the axisymmetrical analysis indicated a more even and homogeneous stress distribution with minor stress concentrations at the bottom of the hole. The Results of analysis in plane strain show that the joints in the vicinity of the storage hole will open up a maximum of 3 mm when the hole is excavated. This is further increased to 13 mm around the top of the hole when the hole is filled with bentonite. Around the bottom of the hole the deformations are calculated to be 5 mm. However, in the real case the displacements will be less due to the confined conditions around the hole. From this study we conclude that the opening of the joints will not exceed some millimeter in the rock mass around the storage hole and the tunnel.

56115 (NP—23919) **Status of nuclear fuel reprocessing, spent fuel storage, and high-level waste disposal. Overview and summary.** Varanini, E.E. III; Maullin, R.L. (California Energy Resources Conservation and Development Commission, Sacramento (USA)). 11 Jan 1978. 43p. Dep. NTIS, PC A03/MF A01.

With regard to the specific question embodied in California's nuclear statutes about the demonstrated and approved permanent terminal disposal of nuclear waste (assuming that the reprocessing question is now most for legislative purposes), the finding of the Energy Commission is that such a technology has not been demonstrated and that it is even questionable to assume that one will be demonstrated before the mid 1980s. Following upon this finding and addressing the broader question of continued implementation of the policy expressed by the nuclear fuel cycle statutes, the evidence indicates that it is not prudent to continue siting nuclear powerplants based on an optimistic assumption that waste management technologies to handle nuclear waste will be developed and scientifically demonstrated. The California Legislature has questioned that optimistic assumption by placing the burden of proof on the developers of a demonstrated, scientifically tested process for the permanent and terminal disposal of nuclear wastes. Such a process does not exist at this time. There are many who are optimistic that the development of such a technology will become a reality in the near future. This overview and the supporting report indicate that this optimism is not warranted. Weapons proliferation and degradation of the biosphere by radioactive waste have proved to be unanticipated, difficult and possibly intractable problems in spite of an overriding confidence that nuclear technology would not present such problems. On the basis of the evidence received by this Commission, there are substantial scientific gaps which preclude proceeding on the basis of faith that all the attendant risks and issues will be resolved.

56116 (ONWI—9(2)) **Technical progress report for the quarter January 1-March 31, 1979.** (Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). 1979. Contract EY-76-C-06-1830. 352p. Dep. NTIS, PC A16/MF A01.

The ONWI program is designed to provide all of the technology and engineering design bases for a waste repository to isolate nuclear waste safely, with protection to the environment. The technical programs required to meet the challenge of the NRC licensing process are site characterization, technology development, and facilities engineering. This document is divided into sections dealing with: science and technology, process/equipment development, systems analysis, geologic exploration, facilities engineering, and site qualification and licensing. (DLC)

56117 (ORNL—5485, pp 106-108) **Environmental chemistry.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

A brief description is given of the kinetic model for predicting the composition of chlorinated estuary or sea water discharged from power plants. Flow of brines through salt beds under thermal gradients was studied. 2 figures. (DLC)

56118 (RHO-BWI-SA—20) **Numerical modeling of the geomechanical response of a rock mass to a radioactive waste repository.** Hardy, M.P.; St. John, C.M.; Hocking, G. (Minnesota Univ., Minneapolis (USA). Mineral Resources Research Center; Dames and Moore, Boston, MA (USA)). Jun 1979. Contract EY-76-C-06-2130. 16p. (CONF-790944—1). Dep. NTIS, PC A02/MF A01.

From 4. international congress on rock mechanics; Montreux, Switzerland (2 Sep 1979).

Geotechnical numerical models capable of predicting the thermomechanical response and groundwater movements around an underground radioactive waste repository are vital to the success of the nuclear waste disposal program. In the absence of directly related engineering experience, the design, risk assessment, and licensing procedures of a repository will be reliant on predictions made using such models. This paper reviews models being used to assist in repository design and summarizes the results of a recent parametric study of underground disposal in basaltic rocks. On the basis of preliminary site data, it is concluded that the allowable areal density of heat-generating waste will be controlled by the stability of placement rooms and the boreholes in which waste canisters are placed. Regional effects including thermally induced upward groundwater flow, appear to present less severe problems.

56119 (RHO-BWI-SA—21) **Basalt near-surface test facility test plans.** Krug, A.D. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jun 1979. Contract EY-77-C-06-1030. 15p. (CONF-790683—2). Dep. NTIS, PC A02/MF A01.

From ONWI-LLL workshop on thermomechanical modeling for a hard rock repository; Berkeley, CA, USA (25 Jun 1979).

The NSTF is under construction at Gable Mountain for in-situ testing, which will be conducted in two phases: Phase I, using electric heaters to simulate nuclear waste canisters in order to study the thermomechanical response of basalt; and Phase II, using spent fuel canisters. The tests planned for Phases I and II are described. (DLC)

56120 (RHO-CD—773) **Interim report on status of containment integrity studies for continued in-tank storage of Hanford high-level defense waste.** Mercier, P.F. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Sep 1979. Contract EY-77-C-06-1030. 25p. Dep. NTIS, PC A02/MF A01.

This interim report supplements technical information reported in RHO-LD-52, Status of Containment Integrity Studies for Continued In-Tank Storage of Hanford Defense High-Level Waste, September 1978. Only new data from the continuing laboratory programs and those studies initiated in the past year are included. Analyses of waste tank concrete integrity continued through the year. Laboratory tests to determine the effect of long-term elevated temperatures on the strength and elastic properties of concrete showed that the modulus of elasticity, compressive strength, and splitting tensile strength continued to decrease as a function of temperature; Poisson's ratio was relatively unchanged. The durability tests of reinforced concrete specimens exposed to simulated waste chemicals showed no evidence of deterioration after 6 months exposure. Temperature cycling effects after 17 cycles showed little change in the compressive strength but a large reduction in the modulus of elasticity. A structural failure mode analysis was initiated to estimate the effect of constant dead load, elevated temperature, and aggressive chemicals on tank structural integrity after 100 years of waste storage. No results are presently available. A report is scheduled for completion in early 1980. An electron microscopy analysis was initiated to determine if microstructural changes in concrete can be detected which would provide a key for correlating relatively short-term laboratory data to predicting long-term structural behavior. Documented results are scheduled for late 1980.

56121 (RHO-LD—45) **Granulometric data 216-B Crib Facilities monitoring well sediments.** Fecht, K.R.; Last, G.V.; Marratt, M.C. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1978. Contract EY-77-C-06-1030. 276p. Dep. NTIS, PC A13/MF A01.

Approximately 3400 sediment samples collected during the drilling of wells in the 216-B Crib Facilities have been analyzed for grain size and calcium carbonate content. The grain size data were used to categorize the sediment samples into sediment classes. The granulometric data, the calcium carbonate data, and the sediment class of each of the 3400 sediment samples are documented in this report.

56122 (RHO-LD—97) **Project plan for inspection and evaluation of Nuclear Fuel Services high-level waste storage system.** Reep, I.E. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Aug 1979. Contract EY-77-C-06-1030. 77p. Dep. NTIS, PC A05/MF A01.

Information is needed about the condition of the high-level waste tanks and their contents in the NFS West Valley, New York reprocessing facility. This project plan will inspect the two carbon steel waste tanks 8D-1 and 8D-2 and characterize and analyze the waste. Soil transport studies will also be conducted around the tanks to determine the consequences of hypothetical tank leakage. Soil thermal properties and the total heat generation rate of the high-level waste will be measured. (DLC)

56123 (SAND—79-0283) **Basic data report for drillhole WIPP 29 (Waste Isolation Pilot Plant-WIPP).** (Sandia Labs., Albuquerque, NM (USA); Geological Survey, Denver, CO (USA)). Sep 1979. Contract EY-76-C-04-0789. 78p. Dep. NTIS, PC A05/MF A01.

WIPP 29 was drilled in Nash Draw (SE 1/4, Sec. 34, T22S, R29E) in Eddy County, New Mexico, to determine subsurface stratigraphy and examine dissolution features above undisturbed salt in the Salado Formation. Determination of dissolution rates will refine previous estimates and provide short-term (geologically) rates for WIPP risk assessments. The borehole encountered, from top to bottom, unnamed Pleistocene deposits (12' with fill material for pad), Dewey Lake Red Beds (203'), Rustler Formation (131'), and the upper 234' of the Salado Formation. A dissolution residue, 105' thick, is at the top of the Salado Formation overlying halite-rich beds. In addition to obtaining nearly continuous core from the surface to total depth (358'), geophysical logs were taken to measure acoustic velocities, density, radioactivity, and formation resistivity. An interpretive report on dissolution in Nash Draw will be based on combined borehole basin data, surface mapping, and laboratory analyses of Nash Draw rocks and fluids. The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes and to then be converted to a repository. The WIPP will also provide research facilities for interactions between high-level waste and salt.

56124 (UCID—18009) **Technical concept for rock mechanics tests, Climax Granite, NTS.** Hearst, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1979. Contract W-7405-ENG-48. 74p. Dep. NTIS, PC A04/MF A01.

If we are to believe our predictions of the thermomechanical behavior of the material surrounding a nuclear waste repository in granite, we must test the computational methods used in making the predictions. If thermal loadings appropriate to a real repository are used, thermally induced displacements and strains are quite small, and available geotechnical instrumentation is only marginally able to measure these effects to the accuracy desired to make thorough tests of the predictions. We outline a three-step program to address these issues. (1) Conduct experiments in which the thermal loading is large compared to that induced by a real repository. This will permit us to make accurate measurements with available instrumentation. (2) Simultaneously, develop improved instrumentation that will enable us to make accurate measurements of motions induced by thermal loadings appropriate to a real repository. (3) Finally, conduct a second set of experiments, with the improved instrumentation and thermal loading similar to that of a real repository in granite. If we can predict the effects of this thermal loading to a few percent over distances of tens of meters for time periods of a few years, and demonstrate that these predictions are correct, we can have reasonable confidence that, using the same methods, we can predict the behavior over thousands of meters for hundreds of years to an order of magnitude. That accuracy should be satisfactory for those distances and times.

56125 (UCID—18125) **Seismic safety in nuclear-waste disposal.** Carpenter, D.W.; Towse, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Apr 1979. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

Seismic safety is one of the factors that must be considered in the disposal of nuclear waste in deep geologic media. This report reviews the data on damage to underground equipment and structures from earthquakes, the record of associated motions, and the conventional methods of seismic safety-analysis and engineering. Safety considerations may be divided into two classes: those during the operational life of a disposal facility, and those pertinent to the post-decommissioning life of the facility. Operational hazards may be mitigated by conventional construction practices and site selection criteria. Events that would materially affect the long-term integrity of a decommissioned facility appear to be highly unlikely and can be substantially avoided by conservative site selection and facility design. These events include substantial fault movement within the disposal facility and severe ground shaking in an earthquake epicentral region. Techniques need to be developed to address the question of long-term earthquake probability in relatively aseismic regions, and for discriminating between active and extinct faults in regions where earthquake activity does not result in surface ruptures.

56126 (UCRL—83285) **Solving the geologic issues in nuclear waste disposal.** Towse, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Sep 1979. Contract W-7405-ENG-48. 33p. (CONF-790948—1). Dep. NTIS, PC A03/MF A01.

From Annual meeting of the American Institute of Professional Geologists; Lafayette, LA, USA (21 Sep 1979).

Technical problems with nuclear waste disposal are largely geological. If these are not solved, curtailment of nuclear power development may follow, resulting in loss of an important element in the national energy supply. Present knowledge and credible advances are capable of solving these problems provided a systems view is preserved and a national development plan is followed. This requires identification of the critical controllable elements and a systematic underground test program to prove those critical elements. Waste migration can be understood and controlled by considering the key elements in the system: the system geometry, the hydrology, and the waste-rock-water chemistry. The waste program should: (1) identify and attack the critical problems first; (2) provide tests and demonstration at real disposal sites; and (3) schedule elements with long lead-times for early start and timely completion.

56127 **Method for calcining radioactive wastes.** Bjorklund, W.J.; McElroy, J.L.; Mendel, J.E. (to Exxon Nuclear Co., Inc.). US Patent 4,152,287. 1 May 1979. Filed date 10 Nov 1976. 6p.

A method for the preparation of radioactive wastes in a low leachability form involves calcining the radioactive waste on a fluidized bed of glass frit, removing the calcined waste to melter to form a homogeneous melt of the glass and the calcined waste, and then solidifying the melt to encapsulate the radioactive calcine in a glass matrix.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 57117, 57194

56128 (DOE/EDP—0055) **Environmental Development Plan: Decontamination and Decommissioning.** (Department of Energy, Washington, DC (USA)). Jul 1979. 60p. Dep. NTIS, PC A04/MF A01.

This EDP system applies to the decontamination and decommissioning of nuclear facilities that are no longer useful or needed. (DLC)

56129 (KBS-TR—32) **Long term mineralogical properties of bentonite/quartz buffer substance.** Jacobsson, A.; Pusch, R. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 158p. (In Swedish). Dep. NTIS (US Sales Only), PC A08/MF A01.

This report shows results from investigations concerning properties in bentonitebased buffersubstances which are suggested to be used when high level radioactive wastes from nuclear powerplants are to be stored finally. Recommended material characteristica of the bentonite to be used are summerized. In an attempt to find geological evidence for bentonite to loose its desireable properties there were no such findings at the temperatures, groundwater situations and pressures which are to be expected at the actual depositing depth (500 m) for a considerable period of time. Concerning biological activity and then specially the mobility and activity of bacteria the conclusion is that there will be little or no influence from them either there is bentonite-sand or compacted pure bentonite in the buffer mass.

56130 (KBS-TR—40) **Ecological transport and radiation doses from ground water borne radioactive matters.** Bergman, R.; Bergstroem, U.; Evans, S. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Dec 1978. 59p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

Turnover of radioactive matter entering the biosphere with ground water has been studied with regard to exposure and dose to critical groups and populations. The main alternatives considered for outflow of radioactive effluents to the biosphere are: outflow in a valley containing wells, outflow to a fresh-water lake, and outflow in a coastal region of the Baltic Sea. Mathematical models of a set of coupled ecosystems on local, regional- intermediate- and global levels have been used for calculations of doses. The intermediate system refers to the Baltic Sea. The mathematical analysis, based on first order kinetics for the exchange of matter in a system according to compartment principles, also includes products in decay chains, i.e. daughter nuclides generated by decay of nuclides under ecological cycling. The time dependent exposures have been studied for certain long-lived nuclides of radiological interest in waste from reprosessed fuel. Dose and dose commitment have been calculted for different release patterns comprising idealised episodes for outflow to the biosphere during short periods and outflow governed by constant leakage from a source on the border between geosphere and biosphere.

56131 (KBS-TR—46) **Temperature distribution in and around the final storage for BWR-fuel.** Tarandi, T. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 41p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Temperature distribution in and around the final storage has been calculated for BWR-fuel. The amount of BWR fuel is 1.4 ton per canister. The canister is deposed 40 years after withdrawal from the reactor. The maximum temperature of 76 deg C at the surface of the canister is reached 10 - 20 years after the time of deposition. The highest temperature in the rock, 60 deg C, occurs about 60 years after the deposition. After 100 000 years the temperature in the storage is only a few centigrades above the initial rock temperature. The heat from the storage reaches the ground surface about 200 years after the deposition. The maximum heat flow, 0.15 W/m^2, occurs about 2 000 years after deposition and is considered insignificant compared for example with solar energy flow of about 100 W/m^2.

56132 (KBS-TR—54-03) **Groundwater movements around a repository. Regional groundwater analyses. Part 1. Initial conditions. Part 2. Long term residual conditions.** Burgess, A. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Oct 1977. 116p. Dep. NTIS (US Sales Only), PC A08/MF A01.

Based on regional models of groundwater flow, the regional hydraulic gradient at depth is equal to the regional topographic gradient. As a result, the equipotentials are near vertical. The permeability distribution with depth influences the groundwater flow patterns. A zone of sluggish flows, the quiescent zone is developed when the permeability decreases with depth. This feature is accentuated when horizontal anisotropy, with the horizontal permeability higher then the vertical permeability, is included. The presence of an inactive zone will be a prerequesite for a satisfactory repository site. The effect of an inclined discontinuity representing a singular geological feature such as a fault plane or shear zone has been modelled. The quiescent zone does not appear to be unduly disturbed by such a feature. However, meaningful quantitative predictions related to the flows in a typical singular feature cannot be made without more specific data on their hydraulic properties. Two dimensional analysis has been made for a site specific section of a candidate repository site at Forsmark, Sweden. The lateral extent of the model was defined by major tectonic features, assumed vertical. Potential gradients and pore velocities have been computed for a range of boundary conditions and assumed material properties. The potential gradients for the model with anisotropic permeability approach the average potential gradient between the boundaries. The result of this study of the initial groundwater conditions will be used as input data for the analyses of the thermomechanical perturbations of the groundwater regime. In the long term, the groundwater flow will return to the initial conditions. The residual effects of the repository on the flow will be discussed in part 2 of this report.

56133 (KBS-TR—54-04) **Ground water movements around a repository. Rock mechanics analyses.** Ratigan, J.L. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Sep 1977. 50p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The determination and rational assessment of groundwater flow around a repository depends upon the accurate analysis of several interdependent and coupled phenomenological events occuring within the rock mass. In particular, the groundwater flow pathways (joints) are affected by the excavation and thermomechanical stresses developed within the rock mass, and the properties, of the groundwater are altered by the temperature perturbations in the rock mass. The objective of this report is to present the results of the rock mechanics analysis for the repository excavation and the thermally-induced loadings. Qualitative analysis of the significance of the rock mechanics results upon the groundwater flow is provided in this report whenever such an analysis can be performed. Non-linear rock mechanics calculations have been completed for the repository storage tunnels and the global repository domain. The rock mass has been assumed to possess orthoganol joint sets or planes of weakness with finite strength characteristics. In the local analyses of the repository storage tunnels the effects of jointorientation and repository ventilation have been examined. The local analyses indicated that storage room support requirements and regions of strength failure are highly dependent upon joint orientation. The addition of storage tunnel ventilation was noted to reduce regions of strength failure, particularly during the 30 year operational phase of the repository. Examination of the local stresses around the storage tunnels indicated the potential for perturbed hydraulic permeabilities. The permeabilities can be expected to be altered to a greater degree by the stresses resulting from excavation than from stresses which are thermally induced. The thermal loading provided by the instantaneous waste emplacement resulted in stress states and displacements quite similar to those provided by the linear waste emplacement sequence.

56134 (KBS-TR—54-06) **Groundwater movements around a repository. Final report.** Lindblom, U.E.; Stille, H.; Gnirk, P.F.; Ratigan, J.L.; Charlwood, R.G.; Burgess, A.S. (Kaernbraenslesaekerhet,

Stockholm (Sweden)). Oct 1977. 127p. Dep. NTIS (US Sales Only), PC A07/MF A01.

The overall goal of this study has been to assess the groundwater flow field in the vicinity of a conceptual high-level radioactive waste repository, situated at a depth of 500 m in the precambrian bedrock of Sweden. Finite element modelling procedures have been used employing nominal and extrapolated data for initial groundwater conditions and precedent data for material properties. The coupling of thermal, rock mechanics, and groundwater flow effects has been achieved by means of quasi-static techniques. The results of these interelated processes have been analyzed for the following identifiable periods of the repository time frame: (1) pre-construction; (2) construction, but pre-emplacement of the waste; (3) post-emplacement of the waste through the significant portion of the thermal cycle; and (4) long term. Assessment of the results of the analysis efforts lead to the following general conclusions: For the conceptual repository design at 500 m depth with a gross thermal loading of 5.25 W/m², the groundwater regime will not be significantly altered by the radiogenic heat dissipation. The long term flow fields will be determined principally by the flow regime prior to construction and can therefore be reliably predicted through establishment of the existing geohydrologica02059NRM 0000

56135 (KBS-TR—55) **Sorption of long-lived radionuclides in clay and rock. Part 1. Determination of distribution coefficients. Part 2. Literature examination.** Allard, B.; Kipatsi, H.; Rydberg, J. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Oct 1977. 51p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

The mechanism of sorption of water soluble species in the natural environment has been discussed. The radiochemical and radiobiological properties of the elements in spent nuclear fuel have been briefly discussed, and 14 of the radioactive products have been selected for studies of the sorption behaviour in contact with natural rock and clay minerals. These 14 elements are Sr, Zr, Tc, I, Cs, Ce, Nd, Eu, Ra, Th, U, Np, Pu and Am. From data available concerning composition and equilibria in natural subsoil waters two standard water compositions have been suggested for the laboratory measurements. Suitable concentrations of the radionuclides and experimental temperatures have been proposed. A batch technique has been used for determination of distribution coefficients for powdered solid materials. Measurements have been performed for all of the 14 elements with granite and bentonite/quartz mixture (10:90) with variation of water composition, nuclide concentration and temperature. Moreover, the effect of variation of the particle size has been studied for granite with Sr, Cs and Am, as well as the sorption in powdered granodiorite, chlorite and silt and on fresh and old rock surfaces (granite). The presence of organic components in bentonite has been confirmed and a preliminary complex formation study with these organics has been performed. An estimation of the valencestate of the actinides U, Np and Pu has been suggested using reasonable assumptions regarding the hydrolysis of the actinides and the presence of Fe(IIE/Fe(IE in natural waters. Using measured or calculated distribution coefficients and considering the chemical properties of the natural water system, relevant retention factors of the radionuclides have been proposed.

56136 (KBS-TR—77) **Nuclide migration from a bedrock repository for spent fuel.** Grundfelt, B. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Aug 1978. 88p. (In Swedish). Dep. NTIS (US Sales Only), PC A05/MF A01.

A study of the migration of radionuclides from a repository for spent, unprocessed fuel is presented. The study makes use of a unidimensional dispersion model developed at BNWL. The results show that a number of nuclides decay significantly during the migration. The doses to future man was calculated in a separate study performed at Studsvik. The dose calculations are based on the activity in-flows, presented in this report, and show that the predominant dose contribution comes from the nuclide radium-226. This nuclide is formed mainly by the decay of uranium-238 which means that the main part of the dose would arise even from a repository for non-irradiated fuel.

56137 (KBS-TR—86) **Diffusivity measurements of methane and hydrogen in wet compacted clay.** Neretnieks, I.; Skajius, C. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jan 1978. 28p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

An experimental determination of the diffusivities of methane and hydrogen through a barrier of compacted clay at a temperature of 50 deg C has been made. The methance molecule is somewhat larger than oxygen, while hydrogen is smaller. Methane and hydrogen were used instead of oxygen in the experiments to circumvent the experimental difficulties in measuring oxygen. The measured diffusivity of methane in compacted clay was $3.9.10^{-11}$ m²/s and the diffusivity of hydrogen in compacted clay $1.8.10^{-11}$ m²/s. The clay was compacted to a density of 2.1 g/cm³ on an air dry basis.

56138 (KBS-TR—87) **Diffusivity measurements in wet compacted clay Na-lignosulfonate, Sr^{2+}, Cs^{+}.** Neretnieks, I.; Skagius, C. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Mar 1978. 27p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Diffusivity measurement of cesium, strontium and sodiumlignosulfonate were made in a wet compacted clay. The density of the clay was 2.1 g/cm³ on an air dry basis. The temperature was 50 deg C. Strontium and cesium are ion exchanged into the clay and will thus be retarded. The measured diffusivities were $5.4.10^{-11}$ m²/s for cesium and $3.3.10^{-11}$ m²/s for strontium. These diffusivity values have been recomputed to describe a case with no ion exchange. In this way they are comparable with diffusivities of other small molecules. These are quite expected values and compare well with previous measurements with methane and hydrogen. Sodiumlignosulfonate with a mean molecular weight of 24000 could not be found on the recieving end of the diffusion cell after more than 800 hours. The diffusivity then must be less than 3.10^{-14} m²/s.

56139 (KBS-TR—88) **Groundwater chemistry at depth in granites and gneisses.** Jacks, G. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Apr 1978. 40p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The place considered for a radioactive waste storage is beneath a local water divide along the eastcoast of southern and central Sweden. pH is fixed by the carbonate system and the ground waters can be expected to be saturated with respect to calcite. pH may vary from about 7,2 to about 8,5 with the most probable value around 8. The content of Cl^- is difficult to asses as it is associated with the presence of relict sea water. Relict sea waters are linked to the postglacial clays and low sections of the terrain. Near local water divides the content of Cl^- is low approaching the atmospheric contribution or below 10 mg/l. The content of F^- is restricted by the solubility of fluorspar and may be about 7 mg/l as a maximum, but normally 3,5 mg/l or lower. SO_4^- seems to be of the same order as the atmospheric contribution or about 15 mg/l. In the deep boreholes sampled so far the contents have been lower. The partial pressure of oxygen in the ground water should be very low. An increasing ironcontent towards depth is likely. Organic substance in the order of a few tenths of mg/l may be present. The local heating of the water close to the storage may bring about precipitation of calcite while the subsequent cooling when the water leaves the storage may result in precipitation of aluminiumsilicates. This may have a sealing effect of the rock.

56140 (KBS-TR—101) **Leaching of Ni-59 from a bedrock depository.** Neretnieks, I. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Apr 1978. 38p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Radioactive metal parts are compacted and placed in concrete boxes. The boxes are placed in a tunnel in good rock at 500 m depth. They are surrounded by a buffer mass consisting of a clay/quartz mixture with very low water permeability. The metal parts consist of zircaloy, stainless steel and inconel. The most important radionuclide in the metals is nickel-59 with a halflife of nearly 80 000 years. It is not quite clear if the nickel in the alloys will corrode or not. In this study it has been assumed that it will be oxidized to Ni(II). The solubility of nickelhydroxide is very low < 1 mg/l in water with pH between 10 and 13. This pH is maintained by dissolution of the hydroxides from the concrete. It is furthermore assumed that organic complexing agents in the groundwater may increase the solubility of nickel to 30 mg/l. If the concrete and the buffer mass are not destroyed, the leach rate of nickel is very low. It will take about 20 million years for all the nickel to escape under these circumstances. The barriers may be degraded by several mechanisms. The clay might be destroyed by the hydroxyl ions from the concrete and the concrete will be degraded as its hydroxyl ions escape. The clay could be destroyed in 100 000 years if very high and unlikely reaction rates are assumed. Under the very unlikely circumstances that the concrete and the clay/quartz mixture becomes very permeable to water flow due to degradation, the maximum leach rate for nickel will be 2.10^{-6} parts per year.

56141 (KBS-TR—103) **Some aspects on colloids as a means for transporting radionuclides.** Neretnieks, I. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Aug 1978. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The diffusivity of a macromolecule through a compacted clay layer was measured. The results indicate that molucules and thus colloids of this size - M = 24 000 - will not diffuse through the clay barrier in any appreciable amount. Another set of experiments indicate that the clay will not be a source of colloids as the montmorillonite particles form a stable gel in groundwater with its rather high Ca^{2+} content. Transport of radionuclides from the repository by adsorption on colloids coming from the clay will thus be small. The colloid content of groundwater from Finnsjoen was measured. This was less than 1 mg/l, so low a colloid content is of little importance. Experiments designed to observe the adsorption of colloidal particles from the clay on rock surfaces were inconclusive.

56142 (KBS-TR—106) **Radiation field and energy deposition in water outside capsules in the final repository.** Lundgren, K.

(Kaernbraenslesaekerhet, Stockholm (Sweden)). May 1978. 50p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

The radiation field outside a capsule of copper containing approximately 500 spent BWR fuel rods has been calculated. An average burnup of 30 000 MWd/tU and a cooling time of 40 years have been assumed. On the surface of the capsule the gamma dose-rate will be of the order of 17 mrem/h and the neutron dose-rate 40 - 95 mrem/h. Interacting with water, ionizing radiation produces free radicals and oxygen. Energy deposition in water outside the above capsule of copper has been calculated to be 1.10^{18} and 3.10^{19} MeV, summed up to 10^4 and 10^6 years, respectively. The neutron and gamma energy deposition in water in the event of any water getting inside the capsule, has also been calculated. Deposition rate after a cooling time of 40 years will be approximately $1.5.10^{14}$ eV/g H_2O,s and energy deposition, summed up to 10^4 and 10^6 years, will be 2.10^{23} and 9.10^{23} eV/g H_2O, respectively. This is true when the water is not in direct contact with the fuel material. Energy deposition in water outside a capsule of lead containing waste from reprocessing has also been calculated and the result is 1 10^{18} and 3.10^{19} MeV, summed up to 10^4 and 10^6 years, respectively (assumed a cooling time of 40 years before storage). The capsule is assumed to have a cladding of titanium.

56143 Fixation of radioactive ions in porous media with ion exchange gels. Mercer, B.W. Jr.; Godfrey, W.L. (to Dept. of Energy). US Patent 4,156,658. 29 May 1979. Filed date 28 Jun 1974. 4p.

PAT-APPL-484,011.

A method is provided for fixing radioactive ions in porous media by injecting into the porous media water-soluble organic monomers which are polymerizable to gel structures with ion exchange sites and polymerizing the monomers to form ion exchange gels. The ions and the particles of the porous media are thereby physically fixed in place by the gel structure and, in addition, the ions are chemically fixed by the ion exchange properties of the resulting gel.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 56086, 56089, 56102, 57177, 57194

56144 (BM-RI—8361) **Effects of heating on radon-222 emanation from domestic uranium ores.** Austin, S.R.; Droullard, R.F. (Bureau of Mines, Denver, CO (USA). Denver Mining Research Center). 1979. 50p. Bureau of Mines, Washington, DC.

Emanation coefficients of 102 samples from 14 domestic areas of past, present, and possible future uranium production were investigated using modifications of the closed-can, gamma-only assay method at and after cooling from 100 to 1,000°C. True annealing probably does not occur below 500°C. In limited investigations at 500°C and above, effects of annealing are masked by the effects of other parameters. Emanation is commonly less at one or more of the steps investigated in the 100 to 500°C range than before heating. This decrease is tentatively attributed to water loss at temperatures dependent upon the minerals present. The average sample emanates least at 300°C; emanation increases with higher temperatures to at least 900°C. Emanation decreases sharply on cooling, but it is partially restored by prolonged exposure to the atmosphere at room temperature. Higher than average emanation of coffinite ores at 500°C and above may be related to destruction of the coffinite crystal structure. 4 figures, 19 tables.

56145 (DP-MS—79-21) **ESCA studies on leached glass forms.** Dawkins, B.G. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1979. Contract EY-76-C-09-0001. 11p. Dep. NTIS, PC A02/MF A01.

Electron Spectroscopy for Chemical Analysis (ESCA) results for frit, obsidian, NBS standard, and Savannah River Laboratory (SRL) glass forms that have been subjected to cumulative water leachings of 36 hours show that [Na] exhibits the largest and fastest change of all the elements observed. Leaching of surface Na occurred within minutes. Surface Na depletion increased with leach time. Continuous x-ray irradiation and argon ion milling induced Na mobility, precluding semiquantitative ESCA analysis at normal operating temperatures. However, the sample stage has been equipped with a liquid nitrogen supply and alkali mobility should be eliminated in future work.

56146 (RHO-SA—103) **Summary of the development of a cost/risk/benefit analysis for the decontamination and decommissioning of the Hanford Z-Plant.** Sexton, R.A.; Melvin, J.P. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 10 Sep 1979. Contract EY-77-C-06-1030. 17p. (CONF-790923—7). Dep. NTIS, PC A02/MF A01.

From Decontamination and decommissioning of nuclear facilities conference; Sun Valley, ID, USA (16 Sep 1979).

Various possibilities are considered for the decontamination and decommissioning of Hanford's Z-Plant plutonium processing facility in a cost/risk/benefit analysis. The four end points of unrestricted, conditional, restricted area with use and restricted area with non use are defined and the criteria and methods of analysis are described.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

56147 (AGNS—35900-CONF-4) **Development of a computerized nuclear materials control and accounting system for a fuel reprocessing plant.** Crawford, J.M.; Ehinger, M.H.; Joseph, C.; Madeen, M.L. (Allied-General Nuclear Services, Barnwell, SC (USA)). Jul 1979. Contract ET-78-C-09-1040. 15p. (CONF-790707—34). Dep. NTIS, PC A02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

A computerized nuclear materials control and accounting system (CNMCAS) for a fuel reprocessing plant is being developed by Allied-General Nuclear Services at the Barnwell Nuclear Fuel Plant. Development work includes on-line demonstration of near real-time measurement, measurement control, accounting, and processing monitoring/process surveillance activities during test process runs using natural uranium. A technique for estimating in-process inventory is also being developed. This paper describes development work performed and planned, plus significant design features required to integrate CNMCAS into an advanced safeguards system.

56148 (HEDL-SA—1777) **Formal training program for nuclear material custodians at Hanford Engineering Development Laboratory.** Scott, D.D. (Hanford Engineering Development Lab., Richland, WA (USA)). May 1979. Contract EY-76-C-14-2170. 6p. (CONF-790707—32). Dep. NTIS, PC A02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

Hanford Engineering Development Laboratory (HEDL) has established a formal training program for nuclear material (NM) custodians. The program, designed to familiarize the custodian with the fundamental concepts of proper nuclear materials control and accountability, is conducted on a semiannual basis. The program is prepared and presented by the Safeguards and Materials Management Section of HEDL and covers 14 subjects on accountability, documentation, transportation, custodian responsibilities, and the safeguarding of nuclear material.

56149 (LA—7996-MS) **Use of sealed tube neutron generators for verification of LWR fuel assemblies.** Lee, D.M. (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

An evaluation is given of using sealed tube neutron generators for the verification of Light Water Reactor (LWR) fuel assemblies. Neutron yields, source moderation, radiation safety, and transportability are discussed.

56150 (LA-UR—79-1476) **In-plant evaluation of a uranium NDA system.** Baxman, H.R.; Langner, D.G.; Sprinkle, J.K.; Sampson, T.E.; Canada, T.R. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-791117—2). Dep. NTIS, PC A02/MF A01.

From ANS topical conference; Kiawah Island, SC, USA (26 Nov 1979).

A uranium solution assay system was developed to allow accurate, timely process control, accountability, and criticality data to be obtained. In it, Ge(Li) γ-ray spectroscopy is integrated with an interactive computer software package. The U concentation range is divided into three material categories: raffinates and distillates, leach solutions, and concentrated leach solutions. (DLC)

56151 (LA-UR—79-2416) **Measurement of Pu contamination at the 10-nCi/g level in 55-gallon barrels of solid waste with a ^{252}Cf assay system.** Crane, T.W. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 10p. (CONF-790928—1). Dep. NTIS, PC A02/MF A01.

From International meeting on monitoring of Pu-contaminated waste; Ispra, Italy (25 Sep 1979).

A combination active/passive nondestructive assay (NDA) system is described for the measurement of a wide range of plutonium-contaminated solid waste. The waste packaged in 55-gal (208 liter) barrels could be of either high or low density with gamma-ray radiation from fission products as high as 1000 R/h. The passive NDA measurement technique consists of counting coincident and total neutrons with ^{3}He-filled proportional detectors. The active assay, which is made after the passive measurement, employs a cyclical irradiation by a ^{252}Cf neutron source followed by delayed neutron counting with the source transferred to a shielded storage

container. Approximately 1000 s are used for the combination active/passive assay. The three standard deviation detectability limit is near the 10-nCi/g fiducial for the passive plutonium measurement and below the fiducial for the active measurement for barrels with a mass of 100 kg or more.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 56087

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 56979

RADIATION SOURCES

OTHER INDUSTRIAL USES

56152 (SAND—79-0401) **Beneficial uses program. Progress report ending December 31, 1978.** (Sandia Labs., Albuquerque, NM (USA)). Mar 1979. Contract AC04-76DP00789. 46p. Dep. NTIS, PC A03/MF A01.

The Beneficial Uses Program is a comprehensive program to develop the necessary technologies for cost-beneficial uses of existing and future surplus radioactive materials. The major portion of the work at Sandia is concentrated in two sub-programs: The Waste Resources Utilization Program and the Separation Technology and Source Development Program. Progress is reported on: (1) the Sandia Irradiator for Dried Sewage Sludge; (2) bacteriology; (3) mycology; (4) virology; (5) animal feeds containing irradiated sewage solids; (6) use of irradiated sewage sludge as fertilizer; and (7) development of ^{90}Sr and ^{137}Cs radiation sources obtained from radioactive wastes. (TFD)

ISOTOPIC POWER SUPPLIES

56153 (LA—7786) **High-pressure seawater corrosion test of a Multihundred-Watt fuel sphere assembly, MHF-259.** Land, C.C.; Matlack, G.M.; Pavone, D. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-ENG-36. 13p. Dep. NTIS, PC A02/MF A01.

A Multihundred-Watt (MHW) fuel sphere assembly (FSA), MHF-259, was tested in the Los Alamos Scientific Laboratory's Hydrostatic Test Facility in 5 l of simulated seawater at 15°C and 69 MPa (10,000 psi) for 300 days. This test was made to determine the effects of such exposure (seawater at 69 MPa) on the $^{238}PuO_2$ fuel containment capability of an FSA and to compare the test results with those from an iridium-clad MHW sphere (MHFT-13), which was severely corroded during its 1-yr exposure to aerated seawater at atmospheric pressure (77.4 kPa). A plutonium release rate of < 0.1 pCi/m^2-s was calculated from the plutonium concentrations in the seawater for both MHF-259 and MHFT-13 under equilibrium test conditions. When the pressure in MHF-259 was released after the initial 31-day exposure period, larger amounts of plutonium were washed through the vents in its iridium shell as the water that had been forced through the vents by the pressure came back out. The comparable release rate for bare $^{238}PuO_2$ fuels is $\sim$ 10 nCi/m^2-s. MHF-259 showed only minimal seawater corrosion damage and, we believe, would have been intact after its 300-day exposure to high-pressure seawater if its postimpact containment shell (PICS) had not been dented at the start of the long-term exposure. In contrast, MHFT-13 was severely corroded. Its PICS was corroded through in five locations adjacent to the closure welds after its 1-yr exposure at atmospheric pressure. The rresults indicate that exposure to high-pressure seawater does not seriously degrade the $^{238}PuO_2$ fuel containment capability of the MHW-FSA.

DESIGN AND FABRICATION

56154 (BMI-X—700) **Heat source component development program. Quarterly report, January 1979-March 1979.** Foster, E.L. Jr. (comp.). (Battelle Columbus Labs., OH (USA)). Aug 1979. Contract W-7405-ENG-92-094. 162p. Dep. NTIS, PC A08/MF A01.

This is the eighth of a series of reports describing the results of several analytical and experimental programs being conducted at Battelle-Columbus Laboratories to develop components for advanced radioisotope heat source applications. The heat sources will for the most part be used in advanced static and dynamic power conversion systems. These reports replace the informal monthly technical letter reports previously prepared and are being utilized so that more cohesive presentations of results can be achieved. The specific efforts in progress during the period covered by this report were in support of the General Purpose Heat Source (GPHS) Development Program that is being led by the Los Alsmos Scientific Laboratory (LASL). These specific efforts were concerned with: analyses of trial designs with emphasis on detailed predictions of the response of Trial Design, including the sensitivity of the response to design and environmental uncertainties, and on comparison of performances of the Trial Design and the Ir Reference Design. It should be noted that considerable reentry thermal analyses have been conducted subsequent to the period covered in this report. In these more recent analyses, significant changes have been made to the heat source properties, and time-dependent boundary conditions. Results of these more recent analyses, as reported in project reviews, differ significantly from some of the results contained in the present report.

56155 (COO—4045-4) **Nuclear powered satellite studies. Annual progress report, July 1, 1978-June 30, 1979.** Kaplan, M.H. (Pennsylvania State Univ., University Park (USA). Dept. of Aerospace Engineering). Jun 1979. Contract EY-76-S-02-4045. 71p. Dep. NTIS, PC A04/MF A01.

Progress achieved during the period July 1, 1978 to June 30, 1979, on US DOE contract No. EY-76-S-02-4045.A002 is reported. Discussions of several pertinent aspects are included, e.g., schedule, personnel, technology developments, and plans. The reporting period represents the third year of activities of a project which is designed to provide continuing support in the area of nuclear space power technology. Important results have been obtained and communicated to the scientific community via publications and presentations. Project personnel have participated in point design efforts, a NASA Space Power Committee, and periodically provide support to Department of Energy activities as the need arises. The report is intended to summarize activities over the past year and provide a basis for continued project support by US DOE.

HYDROGEN

56156 (CONF-781142—) **Proceedings of the DOE chemical/hydrogen energy systems contractor review.** (Brookhaven National Lab., Upton, NY (USA)). May 1979. Contract EY-76-C-02-0016. 459p. Dep. NTIS, PC A20/MF A01.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

This volume contains 45 papers as well as overviews of the two main project areas: the NASA Hydrogen Energy Storage Technology Project and Brookhaven National Laboratory's program on Electrolysis-Based Hydrogen Storage Systems. Forty-six project summaries are included. Individual papers were processed for inclusion in the Energy Data Base.

PRODUCTION

REFER ALSO TO CITATION(S) 56782

ELECTROLYSIS

REFER ALSO TO CITATION(S) 56183

56157 (CONF-781142—, pp 13-25) **Development status of solid polymer electrolyte water electrolysis for large scale hydrogen generator.** Russell, J.H.; Nuttall, L.J. (General Electric Co., Wilmington, MA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

In a joint US Department of Energy, electric and gas utility, and General Electric Company sponsored program, the Direct Energy Conversion Programs of the General Electric Company is developing the solid polymer electrolyte water electrolysis technology for large scale hydrogen generation applications. The goals for this program, as established on the basis of a design study for a 58-MW plant conducted in 1975, are to achieve an overall efficiency of 90% with a system design capable of achieving, in production, a capital cost of $82/KW. The progress to date under the technology improvement tasks of the program toward achieving these goals has been significant and is summarized, as are the results to date of the hardware scale-up program. Preliminary testing of a single 2-1/2 ft^2 cell module has been completed and a three-cell module is now on test. Estimated production plant costs based on the present status of the technology together with the associated cost for the hydrogen produced are also shown.

56158 (CONF-781142—, pp 31-36) **Optical investigation of the oxides of iridium in relation to their electrocatalytic activity.** Pollak, F.H. (Yeshiva Univ., New York, NY); Shin, S.H.; Reames, F.M. May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The time dependence of the reflectivity changes of an Ir-metal catalyst surface in a 1N H_2SO_4 electrolyte in conjunction with electrochemical determinations was investigated. Our results indicate the formation and dissolution of an oxide layer on the Ir-metal surface. In addition, cyclic voltammogram measurements have been performed on oriented single crystals of IrO_2. This study indicates that IrO_3 is a very important intermediate species prior to oxygen evolution and that the formation of IrO_3 is the rate-limiting process.

56159 (CONF-781142—, pp 37-42) **Advanced alkaline electrolysis system.** Yaffe, M.R.; Murray, J.N. (Teledyne Energy Systems, Timonium, MD). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

This report updates work done at Teledyne Energy Systems in the field of alkaline water electrolysis for the production of hydrogen. The results of high temperature studies (Tasks 1 and 2), and baseline high temperature electrolysis system studies (Tasks 2 and 3) are presented. A discussion of advanced component/system testing now in progress is also presented (Task 4).

56160 (CONF-781142—, pp 43-49) **Energy losses occurring in and new electrode concepts for alkaline electrolyzers.** Moran, P.J.; Stoner, G.E. (Univ. of Virginia, Charlottesville). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Polycrystalline whisker electrodes and minimization of time-dependent increases in cell voltage are discussed as means of increasing the efficiency of electrolyzers. (LK)

56161 (CONF-781142—, pp 81-85) **Cost/benefit analysis of alternative hydrogen production technologies.** Weinstein, K.; Rubin, M.; Disabato, T. (Booz, Allen, and Hamilton Inc., Bethesda, MD). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

This paper is a synopsis of a study that was conducted for the Assistant Director for Chemical and Physical Systems of the Energy Storage Division. The study analyzed the economic factors affecting industry's decision to commercialize coal feedstock and electrolytic processes for producing hydrogen. Two issues of importance to Department of Energy policymakers were explored: what level of financial assistance are necessary to achieve given market penetration rates by the year 2000; if it is beneficial for government to assist industry, how may the government structure its participation in the commercialization process. The time horizon for the study was the year 2000. It was assumed that no new significant applications for hydrogen would develop during the timeframe of the analysis.

56162 (CONF-781142—, pp 101-109) **Status report on the Westinghouse hydrogen production process.** Parker, G.H. (Westinghouse Electric Corp., Pittsburgh, PA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The Westinghouse Hydrogen Production Process is a hybrid electrochemical/thermochemical process for decomposing water into hydrogen and oxygen. The development program is based on the desire to have a process development unit (PDU), operating at the pressures, temperatures, and performance levels desired for a commercial unit, in service by 1983. The program status is discussed with emphasis on the description of a closed cycle laboratory model that has been designed and constructed during 1978.

56163 (CONF-781142—, pp 187-192) **Hydrogen production by photoelectrolytic decomposition of water using solar energy.** Rauh, R.D. (EIC Corp., Newton, MA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The principal obstacle to the efficient photoelectrolysis of water using solar energy is the lack of robust semiconductors with appropriate band gaps and electron affinities. The design of anodically stable metal oxide semiconductors which are sensitive to visible light has been a major focus of research during the present year. This is accomplished by employing metals with d electrons in order to form a valence band of non-bonding origin rather than of deep-lying M-O bonding parentage.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 56162

56164 (CONF-781142—, pp 111-118) **Materials corrosion studies for sulfuric acid vaporizer.** Krikorian, O.H. (Univ. of California, Livermore). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A study is in progress at the Lawrence Livermore Laboratory to test and evaluate materials for a sulfuric acid vaporizer under conditions that simulate actual operating conditions for the thermochemical hydrogen cycles under investigation at the General Atomic and Westinghouse laboratories. Two types of materials are being considered: conventional alloys coated or clad with corrosion resistant materials and ceramic materials. These conclusions can be drawn from the work thus far. The high silicon cast iron alloys, Duriron and Durichlor-51, show some promise as container and heat exchanger materials for boiling of H_2SO_4 in short range applications. Quality control will be an important problem in the manufacture of these materials, particularly in regard to internal porosities and other non-uniformities in material characteristics. Machining and milling operations will need to be developed that will not damage alloy surfaces and lead to subsequent corrosion. Of the two alloys, Durichlor-51 has so far demonstrated better corrosion resistance, and is the one that we would prefer for the application. Ceramic materials such as SiC and Si_3N_4 show excellent corrosion resistance, and if fabrication methods become available for their use as heat exchangers, should provide very durable materials. The $CrSi_2$ also shows excellent corrosion resistance, and if reliable coatings can be applied to heat exchanger alloys, should provide an alternative material.

56165 (CONF-781142—, pp 119-129) **Bench-scale investigations and process engineering on the sulfur-iodine cycle.** Schuster, J.R.; Caprioglio, G.; McCorkle, K.H.; Ohno, T. (General Atomic Co., San Diego, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The status of the engineering (process design, process energy requirements, projected improvements) and bench-scale (subunits 1, 2, and 3, closed loop cycle simulator) studies is given.

56166 (CONF-781142—, pp 131-138) **Thermochemical hydrogen review panel.** Funk, J.E. (Univ. of Kentucky, Lexington). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The objective of the thermochemical hydrogen review panel is to provide the US Department of Energy evaluations of the state of development of the various thermochemical hydrogen production processes. The first process considered was the hybrid sulfuric acid process as being developed by Westinghouse. Major findings of the evaluation are presented.

56167 (CONF-781142—, pp 145-161) **Methods for calculation of Engineering parameters for gas separations.** Lawson, D.D. (Jet propulsion Lab., Pasadena, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Estimation of the energy of vaporization and molar volume by the group additivity methods, estimation of vapor pressure, estimation of gas solubilities in non-polar liquids, and miscibility of liquid systems are discussed. By use of a small programmable hand calculator it is possible to screen new schemes of gas separation for candidate thermochemical cycles.

56168 (CONF-781142—, pp 163-170) **Thermodynamics of thermochemical cycles based on the decomposition of sulfuric acid.** England, C. (Jet Propulsion Lab., Pasadena, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

An analysis of the thermodynamics of thermochemical cycles is presented. Cycles based on the decomposition of sulfuric acid are compared with ideal cycles, based upon considerations of required changes in entropy and the Gibb's function. The analysis shows that the entropy change for the decomposition of sulfuric acid contributes to the engineering difficulties of these cycles. Considerations based on thermodynamics are suggested as a means to select new cycle chemistry.

56169 (CONF-781142—, pp 177-185) **Potential heat exchange fluids for use in sulfuric acid vaporizers.** Lawson, D.D.; Petersen, G.R. (Jet Propulsion Lab., Pasadena, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A series of liquids have been screened as candidate heat exchange fluids for service in thermochemical cycles for hydrogen production that involve the vaporization of sulfuric acid. The required chemical and physical criteria of the liquids are described, and the results of some preliminary high temperature test data are presented.

56170 (ORNL—5485, pp 181-182) **Inorganic chemistry of hydrogen cycles.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Investigations into the thermal decomposition of metallic oxides (CuO, Co_3O_4, Fe_2O_3), two new copper(II) hydroxoiodides, enthalpy of formaion of potassium chromate, Fe/N(Br,K) cycle and Ce/Ce(Ti,Na) cycle are briefly described.

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

56171 (CONF-781142—, pp 171-176) **Photocatalytic generation of hydrogen on irradiation of acidic solutions of dirhodium tetrakis 1,3 diisonitrilopropane dication.** Gray, H.B.; Miskowski, V.M.; Gupta, A. (California Inst. of Tech., Pasadena). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A bridged dimeric rhodium (I) complex has been synthesized which undergoes protonation in acid media. The acid solution evolves hydrogen when irradiated with 546 nm radiation and forms a two electron oxidized product. Irradiation in sulfuric acid (9 M) in presence of Fe^{2+} also yields H_2. The oxidized complex is reconverted to starting material by Fe^{2+}. Spectroscopic and flash photolytic studies have been carried out in order to elucidate the mechanisms of these photoprocesses.

COAL GASIFICATION

REFER ALSO TO CITATION(S) 56161, 56183

STORAGE

56172 (CONF-781142—, pp 305-313) **Comparative advantage and applications study of hydrogen storage techniques.** Iannucci, J.J.; Robinson, S.L. (Sandia Labs., Livermore, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Storage at the production point (solar hydrogen production and off-peak electrolysis hydrogen production), the distribution point, and the end use point are discussed.

CHEMISORPTION

REFER ALSO TO CITATION(S) 56190

56173 (CONF-781142—, pp 225-233) **Development of hydrogen storage materials for application to energy needs.** Lundin, C.E.; Liu, J.; Magee, C.B. (Univ. of Denver, CO). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Hydriding characteristics of rare-earth based, AB_5, quaternary alloys; AB_2, Laves phases; and Ti-base, β solid solution alloys are discussed. Relationships between intermetallic compound structures and hydride formation are considered.

56174 (CONF-781142—, pp 235-244) **Development of new hydrogen storage systems for automotive hydrogen fuel storage.** Sheridan, J.J. III; Eisenberg, F.G.; Shu, P.S.; Raman, S.V. (Air Products and Chemicals, Inc., Allentown, PA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Work is currently being done on developing new Mg-based alloy systems for hydrogen storage for automotive use. Target properties are a one atmosphere decomposition temperature less than 240°C and a capacity greater than 3% by weight. The two basic approaches being followed are: (1) chemical effects - use of a second metal which has a lower hydride stability than Mg in order to lower the stability of the entire alloy; (2) geometric effects - decreasing the stability of MgH2 by alloying a second metal which contracts the lattice of Mg. These two approaches are being investigated experimentally, and the results indicate that both effects could be important.

56175 (CONF-781142—, pp 245-250) **Mechanisms of surface poisoning of metal hydrides.** Sandrock, G.D.; Goodell, P.D. (International Nickel Co., Inc., Suffern, NY). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A Department of Energy funded program to study the surface poisoning of hydrides is described. The three hydrides to be studied are: FeTi, $Fe_{0.9}Mn_{0.1}Ti$, and $LaNi_5$. The gaseous impurities that will be studied are: O_2, H_2O, and CO.

56176 (CONF-781142—, pp 251-259) **Bulk hydrogen storage: engineering-scale tests.** Rosso, M.J.; Strickland, G. (Brookhaven National Lab., Upton, NY). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The engineering problem in the bulk storage of hydrogen in the from of metal hydrides is caused by the expansion of the alloy as the hydrogen in absorbed. Two approaches being investigated to alleviate build up of stress in the bed are periodic fluidization of bed material and limiting the height of the bed by having the hydride inside small-diameter tubes. Solutions to a second problem related to the inherently poor thermal conductivity in fixed beds of fine particles will be sought. All of this work deals with beds of TiFe-based hydrides.

56177 (CONF-781142—, pp 261-270) **First year performance report: large diameter TiFeMn hydrogen storage vessel.** Hadden, L.D.; Billings, R.; Simons, H.; Ruckman, J.; Woolley, R. (Billings Energy Corp., Provo, UT). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A metal hydride vessel with approximately 55 lbs of hydrogen storage capacity has been installed and tested as part of the Hydrogen Homestead Project in Provo, Utah. Operational performance behavior of this vessel has been monitored via computer over a one-year period. Heat transfer characteristics have been evaluated and attempts have been made to observe a hydride packing problem in such a large diameter vessel. Some of the results obtained on the operation, instrumentation, and test program along with recommendations for future work to be done are discussed.

56178 (CONF-781142—, pp 289-294) **Microcavity systems for automotive applications.** Teitel, R.J.; Henderson, T.M.; Luderer, J.E. (Robert J. Teitel Associates, San Diego, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A representative microcavity system for the onboard storage of hydrogen on automobiles was defined and compared to a hybrid metal hydride storage system. In comparison to the metal hydride system, the microcavity system reduced storage weight and costs by half, and required approximately twice the storage volume. It was concluded that the potential advantages of onboard microcavity hydrogen sotrage, when compared to metal hydride and other storage techniques, make it an attractive alternative. Well established data on the properties and characteristics of microsphere beds are not currently available. A substantial extension of this data base is required before the utility of the microcavity storage concept can be adequately quantified.

56179 (CONF-781142—, pp 295-304) **Hydrogen storage devices for automobiles.** Strickland, G. (Broohhaven National Lab., Upton, NY). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Three hydrogen storage devices are discussed: a cryogenic container of liquid hydrogen, a pressure vessel filled with metal hydride, and a low-pressure container of glass microballoons containing highly pressurized hydrogen. The first two have been successfully demonstrated in vehicles; the third is still in the conceptual stage. Some estimated performance are provided.

56180 (CONF-781142—, pp 413-416) **Modeling solid hydrogen storage beds.** Fisher, P.W.; Mitchell, S.E.; Watson, J.S. (Oak Ridge National Lab., TN). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A model being developed at Oak Ridge National Laboratory to predict the behavior of metal hydride beds which are used for hydrogen storage assumes that hydrogen is always in equilibrium with the metal hydride, and that no pressure drop occurs in the bed. The model is being tested by comparing the results obtained for it with data reported by Strickland and Yu from a cylindrical bed containing 84 lb of iron-titanium alloy.

UNDERGROUND

REFER ALSO TO CITATION(S) 56182

56181 (CONF-781142—, pp 271-277) **Underground storage of hydrogen.** Randolph, P.L.; Foh, S.E.; Sinnott, J. (Inst. of Gas Tech., Chicago, IL). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A program to investigate storage of hydrogen in aquifers, depleted natural gas fields, washed salt caverns, and mined caverns is described.

CRYOGENIC

REFER ALSO TO CITATION(S) 56179

TRANSPORT

REFER ALSO TO CITATION(S) 56188, 56191

56182 (CONF-781142—, pp 279-288) **Assessment of hydrogen compressor technology energy storage and transmission systems.** Veziroglu, T.N. (Univ. of Miami, FL); Phadke, L.G.; Foster, R.W.; Escher, W.J.D. May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

An overview is given of a Department of Energy sponsored assessment of hydrogen compressor technology. Compression systems in natural gas service are reviewed; present day hydrogen compressor systems are discussed; theoretical gas-dynamic analysis findings are reported; and material aspects are considered.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 56161

56183 (CONF-781142—, pp 67-79) **Economics and market potential of hydrogen production.** Scherkenbach, W.W.; Dohrmann, D.R. (Hittman Assoicates, Inc., Columbia, MD). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A study was undertaken to evaluate the economics of producing hydrogen from coal and from water and to assess the market potential for this hydrogen in chemical and fuel applications. Results of this study are summarized.

INDUSTRIAL AND COMMERCIAL USE

56184 (CONF-781142—, pp 393-397) **Demand and supply of hydrogen as chemical feedstock in the USA.** Huang, C.J. (Univ. of Houston, TX); Tang, K.K.; Kelley, J.H.; Berger, B.J. May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The findings of a workshop of future demand and supply of hydrogen as a chemical feedstock are summarized. There are no compelling economic reasons for chemical industry users of hydrogen to use other than natural gas and oil as sources of hydrogen at the present time. Financial incentives would have to be provided by the Government for industry to consider installing plants which produce hydrogen from coal or water electrolysis in the next several years. Natural gas curtailments are worrisome, but the impact to date has been of critical importance only in certain regional areas. The prospect of future curtailment is of great concern to the industry. At the present, there is no more interest in obtaining hydrogen by coal gasification when new sources of hydrogen must be found than by electrolysis of water, except for small user applications. It is likely that the development of high-pressure (~ 450 psi) coal gasification processes for hydrogen will be technically successful. Development requires continued Government support. Production and distribution of syngas ($CO + H_2$) by coal gasification is an option worth being considered for industrial users of hydrogen and gaseous fuel. New pipelines may be needed to distribute coal gasification products (H_2 or syngas). Technology is available to distribute these products at moderate pressures. It is recommended that the distribution at high pressures (greater than 2000 psi) should be studied to determine the extent of problems and their respective solutions.

56185 (CONF-781142—, pp 399-408) **Natural gas supplementation with hydrogen.** Guerra, C.R.; Nielsen, D.C.; Griffith, J.E.; Kelton, K. (Public Service Electric and Gas Co., Newark, NJ). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The potential supplementation of natural gas with hydrogen has been evaluated. The studies included: (1) combustion tests of gas blends in burners and appliances, (2) computation of capacity of a distribution network and system adjustments to deliver gas blends, (3) measurement of gas leakage from prototype joints of mains removed from a gas distribution grid, and (4) regulatory aspects of distributing hydrogen to customers through the natural gas distribution system. The results show that main burners can burn blends with up to 20-25% hydrogen in natural gas, but target pilots limit the hydrogen concentration to 6-11%. After modification of pilot orifice or increase in gas for supply pressure, blends with up to 20% hydrogen were found satisfactory for use in most burners and appliances. The flow studies indicate that natural gas with up to 20% hydrogen could be readily adapted to utility operations at the gas pressure and flows used in the distribution, utilization and service subsystems of the grid. The metering station appears to be the most suitable site for introducing hydrogen into the distribution system. Blends of natural gas with up to 40% hydrogen by volume do not result in increased rates of gas leakage through pipeline joints when compared with leakage rates for straight natural gas. There are no regulatory constraints that would prohibit distributing blends of hydrogen with natural gas in New Jersey.

PROPERTIES

56186 (CONF-781142—, pp 205-211) **Hydrogen compression by metal hydrides.** Lynch, F.E. (Denver Research Inst., CO). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Operating principles, performance, and energy requirements of hydride compressors are discussed.

56187 (CONF-781142—, pp 341-345) **Influence of microstructure on the resistance of low strength ferrous alloys to gas phase hydrogen degradation.** Wachob, H.F. (Failure Analysis Associates, Palo Alto, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The proposed research will have two primary objectives: (1) to establish the influence of various microstructures on the susceptibility of a mild steel to hydrogen degradation; and (2) to determine the least susceptible microstructure which can be obtained commercially through standard thermal processing. The materials to be used in the study are: a low strength steel similar to those materials that are presently used in the natural gas pipeline system and a medium strength low-alloy steel. The purpose for using this medium strength steel (HSLA) is that the steel and natural gas companies have proposed to use the X70-X80 HSLA grades of steel in future line pipe and structural applications. Several systematic variations in the microstructure of those materials will be investigated. Base line mechanical properties will be obtained at high and low strain rates. Fractographic examinations of the cyclically cracked surfaces will be performed in order to delineate the effects of microstructure, and alternating applied stress intensity or crack velocity on the final crack path features produced in the gaseous hydrogen environment.

56188 (CONF-781142—, pp 347-349) **Hydrogen compatibility of structural materials for energy storage and transmission.** Hoover, W.R.; Anderson, R.B.; Robinson, S.L.; Spingarn, J.R.; Stoltz, R.E. (Sandia Labs., Livermore, CA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

The feasibility of transporting gaseous hydrogen through the existing natural gas pipeline network is being assessed. The hydrogen compatibility of ferritic pipeline steels and their weldments are being evaluated by laboratory tensile and fracture toughness tests in high pressure hydrogen. The behavior of flawed pipeline segments are being characterized by burst tests and by long-term exposure to a simulated pipeline environment. A516-70 steel has been chosen for initial hydrogen compatibility tests because it is believed to be typical of existing pipeline steels.

56189 (CONF-781142—, pp 351-365) **Hydrogen embrittlement of A-106 steel.** Louthan, M.R. Jr.; McNitt, R.P.; Sudarshan, T.S.; Murali, J.; Adler, T.A. (Virginia Polytechnic Inst., Blacksburg, VA). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Tensile, notched tensile, disc rupture and fracture mechanics tests of samples machined from the pearlitic-ferritic pipeline steel, A-106 grade B, have shown that this alloy is susceptible to hydrogen embrittlement. Tests in 7 to 14 MPa hydrogen gas and tests in air after prolonged storage in 14 MPa hydrogen gas have shown that hydrogen exposure reduces the strength and ductility of the steel, increases the probability of fracture by cleavage or quasi-cleavage mechanisms, lowers the stress intensity or J/sub c/ for crack propagation and reduces the cycles to failure in low cycle fatigue or ratcheted tensile type tests. These adverse hydrogen effects are promoted by sharp notches and triaxial loadings or large degrees of constraint. Surface finish, hydrogen purity and test strain rates also play important roles in determining the susceptibility to hydrogen damage. However, in spite of these clear indications of hydrogen embrittlement susceptibility, no delayed failures have been produced in any samples, even when the samples were held for thousands of hours under cyclic biaxial stresses after being loaded to within 75% of the ultimate rupture pressure. These results are rationalized by considering the effect of stress state on hydrogen embrittlement mechanisms.

56190 (CONF-781142—, pp 409-412) **Kinetics of hydrogen entry from TiFe$_{0.86}$Mn$_{0.11}$H/sub x/.** Wachob, H.F. (Failure Analysis Associates, Palo Alto, CA); Nelson, H.G. May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Hydrogen permeation measurements were made using a tubular SAE 1020 steel specimen that had eigher an FeTiH/sub x/ or $TiFe_{0.86}Mn_{0.11}H$/sub x/ packed into the I.D. of the reduced gage length section. Using the hydrogen activity level as a measure of the degree of mechanical degradation that could occur in this low strength steel, the results indicate that there should be no enhanced degradation of this steel in intimate contact with either FeTiH/sub x/ or $TiFe_{0.86}Mn_{0.11}H$/sub x/.

56191 (CONF-781142—, pp 367-382) **Evaluation of laser welding techniques for hydrogen transmission.** Mucci, J.; Harris, J.A. (Pratt and Whitney Aircraft Group, West Palm Beach, FL). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

This program was established to determine the feasibility of laser beam welding as a fabrication method for hydrogen transmission and is a precursor in the effort to systematically provide the technological base necessary for large-scale, economic pipeline transmission of fuel for a hydrogen energy system. The study contributes to the technology base by establishing the sensitivity of two classes of steels to gaseous hydrogen environment effects and determining the effect of conventional weld processes and laser beam welding on properties. Screening evaluation of the tensile, low-cycle fatigue and fracture toughness properties and metallurgical analyses provide the basis for concluding that laser beam welding of AISI 304L stainless steel and ASTM A106B carbon steel can produce weldments of comparable quality to those produced by gas-tungsten arc and electron beam welding and is at least equally compatible with 13.8 Mpa (2000 psig) gaseous hydrogen environment.

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 56789, 56870

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 56757

PROPERTIES

REFER ALSO TO CITATION(S) 56050

PREPARATION

REFER ALSO TO CITATION(S) 56005

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 55940

56192 **Reformed hydrocarbons and alcohols from fuel alloys and reforming agents.** Michaels-Christopher, V. US Patent 4,110,082. 29 Aug 1978. Filed date 31 Jan 1977. 8p.

This invention relates to the manufacturing of quality engine fuels (hydrocarbons and alcohols) from hydrogenating fuel alloys and reforming agents, containing iron-manganese-carbon, and mixtures of water and carbonaceous materials. The hydrocarbons are stored as metal compound powders.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 56249, 56251, 56819

56193 (STU—78-4357) **Simple and cheap plant for the fermentation of methane.** Ellegaard, A.; Ekehorn, E.; Fraendberg, B.; Jonsson, A.; Kenamets, H.; Weibull, G.; Zetterqvist, A. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Jan 1979. 19p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A plant for the fermentation of methane has been built using only easily available construction elements. The plant has been built at a farm with cattle. The manure from these is used at the plant for the fermentation of methane. The gas produced is used for space heating. In the manure obtained after the fermentation process the nitrogen is more accessible than it was before the fermentation. Thus the manure is more efficient as fertilizing substance. It is stated that the introduction of fermentation of methane will decrease the costs for space heating, electricity consumption, and fertilizers.

56194 **Bibliography of anaerobic digestion.** Abeles, T.P.; Freedman, D.F.; Ellsworth, D.A.; DeBaere, L.A. Cincinnati, OH; Municipal Environmental Protection Agency (1978). 119p. (NP—23968).

The bibliography includes 11 major topics covering research dealing primarily with anaerobic digestion. Particular emphasis has been given to anaerobic digestion of farm animal manures. Topics included are: design parameters, influent, effluent, biogas, operating parameters, laboratory analyses (methods), economics, integrated systems, environmental aspects, social aspects, and general reviews. An author index is included.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 56782, 56803

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 55940, 56192

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 56249

PREPARATION

REFER ALSO TO CITATION(S) 55951, 55952, 55979

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 56865

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 56752

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 57084

SOLAR ENERGY

REFER ALSO TO CITATION(S) 56815

56195 (DOE-tr—188) **Interdisciplinary research program for the development of solar energy (PIRDES). Activity report, July 1975-August 1976.** (Centre National de la Recherche Scientifique, 75 - Paris (France)). [nd]. Translation source information not available. 31p. Dep. NTIS, PC A03/MF A01.

The solar energy research program at the Centre National de la Recherche Scientifique in Paris is outlined. The research program involves the general areas of solar housing, thermodynamic conversion, photovoltaic conversion, bioconversion, and solar thermochemistry. (WHK)

56196 (SERI/PR—43-331) **Host for international visitors. Progress report, July 1, 1978-June 30, 1979.** (Solar Energy Research Inst., Golden, CO (USA)). Aug 1979. Contract EG-77-C-01-4042. 85p. Dep. NTIS, PC A05/MF A01.

Approximately 300 international visitors, representing 63 countries, visited SERI for purpose of information exchange during the reporting period (1 July 78 to 30 July 79). This report describes SERI's activities in hosting these visitors and provides some insights into the characteristics of the visitor set. All visitors, with their full address and date of visit, are tabulated.

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 56316

56197 (DOE/ET/20172—1) **Solar Energy Meteorological Research and Training Site: Region 5. Annual report, 30 September 1977-29 September 1978.** Rao, C.R.N.; Hewson, E.W. (Oregon State Univ., Corvallis (USA). Dept. of Atmospheric Science). Jan 1979. Contract EY-77-G-06-1059. 33p. Dep. NTIS, PC A03/MF A01.

The primary facility which is to be a benchmark site for the acquisition of research quality solar radiation and solar energy related meteorological data has been set up and will be fully operational in the near future. The training program has been established with the introduction of two, two-quarter courses on solar radiation and meteorological measurements and on atmospheric radiative processes. Also, as part of the training program, a week-long workshop on solar energy measurement and instrumentation was conducted during the summer of '78 and a series of seminars on solar energy related topics, catering to both professionals and non-professionals, was arranged during the 1977-78 academic year. A meeting of solar radiation scientists from the five states of the region was held in Corvallis (August '78) to explore the feasibility of setting up a regional network of stations to acquire research quality solar radiation and meteorological data. Useful global irradiance measurements have been made at the five sites, making up the general quality network in Oregon, over the greater part of the year.

56198 (DOE/TIC—10193) **Input data for solar systems.** Cinquemani, V.; Owenby, J.R. Jr.; Baldwin, R.G. (National Climatic Center, Asheville, NC (USA)). Nov 1978. Contract EX-76-I-01-1041. 203p. Dep. NTIS, PC A10/MF A01.

Normals (30-year mean values) of maximum, minimum, and average temperatures for a month or year, and of heating and cooling degree days are tabulated. Average daily values of total hemispheric (global) solar radiation on a horizontal surface were based on corrected hourly measurements for 26 stations and derived values from the corrected measurements for the remaining 222 stations. Most of the average values are based on a 24-25 year period. (MHR)

56199 (ISM—235) **Simple methodology for generating solar percentage graphs based on actual winters.** Hodges, L.; Block, D.A.; Ward, W.O. (Iowa State Univ. of Science and Technology, Ames (USA)). 1979. Contract W-7405-ENG-82. 4p. (CONF-791022—6). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

Easy-to-use solar percentage graphs using real meteorological data have been generated for the use of passive designers in Iowa. To use the graphs the designer must estimate four variables (building heat loss coefficient, glass area, storage heat capacity, and internal heat generation) and form ratios of these quantities. From the appropriate graph and its accompanying formula a designer can quickly estimate the solar performance and auxiliary heat requirement of a building. Such graphs can be generated by any convenient calculation method. Ours were generated by a simple heat balance method carried out separately for each night and day; this method and some of its uses are described.

56200 (NMEX—25) **Pyranometer station for the assessment of solar energy influx in eastern New Mexico. Final report, December 12, 1976-June 1, 1978.** Sittler, O.D.; Agogino, M.M. (New Mexico State Univ., Las Cruces (USA). New Mexico Energy Inst.). May 1979. 51p. New Mexico Energy Inst., P.O. Box 3 EI, Las Cruces, NM.

This project was undertaken to improve the data base for estimating solar energy influx in eastern New Mexico. A precision pyranometer station has been established at Eastern New Mexico University in Portales. A program of careful calibration and data management procedures is conducted to maintain high standards of precision and accuracy. Data from the first year of operation were used to upgrade insolation data of moderate accuracy which had been obtained at this site with an inexpensive pyranograph. Although not as accurate as the data expected from future years of operation of this station, these upgraded pyranograph measurements show that eastern New Mexico receives somewhat less solar energy than would be expected from published data. A detailed summary of these upgraded insolation data is included.

56201 (SERI/RR—36-306) **Application of Monte Carlo techniques to insolation characterization and pediction. Status report, 1 October 1978-1 June 1979.** Bird, R.; Hulstrom, R. (Solar Energy Research Inst., Golden, CO (USA)). Jul 1979. Contract EG-77-C-01-4042. 20p. Dep. NTIS, PC A02/MF A01.

The Monte Carlo method is used to investigate solar radiaion transport through the atmosphere and its reflection from the earth's surface. The rigorous model used allows a detailed understanding of the various aspects of the radiation field at the earth's surface. This knowledge can be used to compare and formulate simple models that are more appropriate for work on solar applications. Phenomena of interest include: the spectral distribution of direct, diffuse-sky, and ground-reflected insolation; the total broadband insolation; circumsolar insolation; the effect of ground albedo; the relationship between insolation on horizontal surfaces and insolation on tilted surfaces; the importance of higher orders of scattering and reflection; the effects of clouds; and the effects of various types of atmospheric aerosols. This report is preliminary in nature in that it is primarily a description of the Monte Carlo method itself and its applications rather than a detailed presentation of results used in solar radiation transport calculations.

56202 (TID—29008, pp 133-136) **Estimation of monthly average diffuse radiation.** Klein, S.A.; Duffie, J.A. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

Correlations which relate the monthly average daily diffuse radiation to the monthly average daily total radiation are derived and compared with existing correlations. Significant differences between these correlations are observed.

56203 **Comprehensive solar energy systems analysis data base in Huntsville, Alabama.** Goddard, J.P. (Univ. of Alabama, Huntsville). pp 43-53 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; University of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

Considerable effort has been expended over a two-year period on the development of a comprehensive solar energy systems analysis data base for the use of the NASA/MSFC solar energy program management. Originally designed to support the Solar Projects Office in the selection of operational test sites, the data base is now of great potential use to other agencies, institutions and individuals as a source of all input information needed for solar energy systems simulation programs. The data base has, stored in its files, climatological and economic data, construction costs, solar and conventional equipment costs and performance, utility rates data, and other information needed to support a full-scale systems analysis. In addition, summary files have been prepared which present packaged information on the more than 300 Standard Metropolitan Statistical Areas (SMSA's) in the nation for the use of the smaller simulation programs such as F-CHART, SOLCOST, etc. Graphics files can provide climatic maps, schematics of typical residences, and solar collector performance curves. The data base is accessible by telephone from any remote terminal able to interrogate the MIRADS system. The development history of this comprehensive systems analysis tool, its current status, and how a solar manufacturer or dealer might come to use it as a one-stop source of marketing information for his product are described.

ECONOMICS

REFER ALSO TO CITATION(S) 56203, 56263, 56280, 56298

56204 (NP—23979) **Testimony of Ms. Omi Walden, Assistant Secretary for Conservation and Solar Applications, FY 1980 authorization hearings.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Feb 1979. 22p. NTIS, PC A02/MF A01.

The overall goal of the Office of Conservation and Solar Applications is to reduce the nation's dependence on petroleum-based fuels. This will be accomplished by reducing waste in the way the Nation uses energy; by providing more energy-efficient technologies and practices for the end-use sectors; and by encouraging a transition to more abundant fuels, especially renewable energy sources such as solar energy. Ms. Walden then reviewed her efforts since she joined the DOE. The major programs for which funds are requested for FY 1980 are discussed. The objectives of the Office of Buildings and Community Systems are summarized and a funding request of $86 million for 1980 is indicated. The objectives and proposed activities of the other major programs are given, with funding requested as follows: Industrial Energy Conservation Program, $42 million; Transportation Programs, $99 million; Office of State and Local Programs, $316 million; Appropriate Technology Small Grants Program, $8.5 million; Office of Solar Applications, $156 million. Ms. Walden also cites the funding requests for subprograms in the budget discussion. (MCW)

56205 **Economic and commercial assessment of solar energy conversion.** London, England; International Solar Energy Society (1977). 100p. (CONF-770760—).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

Ten individually abstracted articles evaluating the economics of solar energy conversion are contained in this report.

56206 **Economic evaluation of solar energy schemes.** Chapman, P.F. (Open Univ., Bucks, England). pp 1-9 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The methods of discounted cash flow analysis are applied to solar space heating and water heating in domestic dwellings. The effect of seasonal demand and tariffs on optimizing the economics of solar systems is considered and shown to depend on the back-up fuel used to complement the solar system. The interaction of solar system and house insulation investments is described, and it is proposed that both systems should be designed and evaluated as one investment. The effects of uncertainities in the discount rate and future fuel prices on determining the cost-effectiveness of solar energy systems are discussed.

56207 Value of solar heating. Lancashire, A.H.; Williams, K.R. (Shell International Petroleum Co., Ltd., London, England). pp 10-19 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The commercial and economic aspects of solar heating systems are discussed. A monograph is given for estimating the payout or earning power of a fuel saving investment taking account of a large number of variables: capital cost, fuel saved, life of the project, time at which the investment is made, interest rate, inflation and discount rate. Use of the chart is explained and illustrated with a couple of examples.

56208 How much investment in conversion devices. Landsberg, P.T. (The Univ., Southampton, England). pp 20-27 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The effect of inflation on computing the return of an investment in a solar energy conversion installation is considered. Numerical values for the various parameters detering the minimum economically viable efficiency are tabulated for thermal and photovoltaic conversion devices. The maximum annual investment for research, development and construction is tabulated for thermal and photovoltaic collectors. The total energy savings for roof top collectors alone in the United Kingdom is estimated to be only 2% of the total UK energy consumption in 1975.

56209 Economics of domestic solar energy in the UK, 1976. Toop, D.J. (British Standards Institution, London, England). pp 28-42 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The thermal and economic demand of a small family living in a conventional house in the United Kingdom are considered. A simple equation is derived for an economic criterion expressing the maximum justifiable total cost for a solar installation in terms of thermal efficiency, average solar flux and simple interest rate. By considering the costs of heating water by conventional means, it is shown that solar panels are currently too expensive and inefficient to justify their installation to save fossil fuel, but would be economic where electricity is to be saved. Average variations in the solar energy flux in London are discussed and insolation data are given. The effects of discounting fuel savings during inflation are considered.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 56276, 57129

56210 (DOE/EA—0087) **Federal photovoltaics utilization program.** (Department of Energy, Washington, DC (USA)). Jun 1979. 40p. Dep. NTIS, PC A03/MF A01.

The potential environmental effects of silicon cell technology are analyzed. It is noted that any potential environmental impacts of this technology occur in connection with manufacturing of silicon cells and proposed applications of photovoltaic systems. However, it is found that there are no known adverse environmental effects associated with the federal photovoltaics utilization program which cannot be mitigated or avoided.

56211 (DOE/EDP—0029) **Environmental Development Plan: solar heating and cooling of buildings.** (Department of Energy, Washington, DC (USA)). Sep 1979. 43p. Dep. NTIS, PC A03/MF A01.

Environmental Development Plans (EDPs) are prepared by the Department of Energy (DOE) to help fulfill the Department's responsibility for the development of environmentally acceptable energy technologies. The EDP provides a common basis for planning, managing, and reviewing all environmental aspects of the energy programs under DOE's jurisdiction. Solar space heating and cooling technologies pose no insurmountable environmental, health, or safety barriers to near-term commercialization. However, a number of environmental concerns are being researched to minimize the environmental, health, and safety hazards of these technologies and to determine any associated impediments to their commercilization. The primary environmental, health, and safety concerns are the use of toxic chemicals in working fluids and storage media; improper disposal of working fluids or storage media; overheating or building fire conditions in the collector or other system components; degradation of air quality in living spaces from mold, fungus, or mildew buildup; and safety hazards of glass breakage by system users or maintenance personnel. Solar space-cooling systems generally include space-heating and water-heating capabilities. A separate Environmental Readiness Document is available for solar hot water systems because heating and cooling systems use much larger collectors and different working fluids. The research program must therefore examine a wider range of materials and designs. The environmental program strategy and management are described. (WHK)

56212 (DOE/EDP—0031) **Environmental development plan photovoltaics.** (Department of Energy, Washington, DC (USA)). Sep 1979. 34p. Dep. NTIS, PC A03/MF A01.

This EDP for the DOE Photovoltaics (PV) Program briefly describes the goals of the program and identifies potential environmental, health, safety, and socioeconomic impacts relevant to solar photovoltaic systems. These impacts are screened for key issues, i.e., those issues considered to be the most serious in nature, that have near-term importance to the program, and for which current knowledge of effects and control is inadequate. A management plan is then presented for conducting and coordinating environmental research in concert with the technology development effort to ensure that identified environmental issues are resolved prior to significant public deployment of the technology. Key environmental concerns associated with the development and deployment of PV systems have been identified by the March 1978 PV EDP in the following subject areas: (1) release of toxic gases during system operation or malfunction; (2) inhalation of toxic gases and dusts by PV industry workers; and (3) solid waste disposal and effects of gases released during PV material mining, manufacture, and disposal. (WHK)

56213 (NP—23943) **Protecting solar access: report of the Governor's special study committee on solar rights.** (Wisconsin Dept. of Administration, Madison (USA). Office of State Planning and Energy). Apr 1978. 34p. NTIS, PC A03/MF A01.

In the spring of 1977 the Wisconsin Office of State Planning and Energy, Department of Administration, under order from former Governor Patrick J. Lucey, established a Special Study Committee to address the legal uncertainties of using the sun as a permanent source of energy. The Governor noted that a major impediment to widespread solar energy use is the uncertainty of an individual's right to an uninterrupted light source once a solar system has been installed. The Committee's charge was to examine in detail the various ways to protect solar access, decide whether or not legislation is necessary, and recommend the form such legislation should take. Following its appointment in June 1977, the committee of solar energy experts examined the full range of techniques available for protecting solar rights. This included all legislation proposed and enacted in other states. The committee weighed the advantages and disadvantages of three general approaches to protecting solar rights - solar easements, land use regulations, and legislative creation of a right to light. The committee's deliberations and conclusions are summarized.

56214 Projected market penetration of solar heating and cooling in the United States. Spewak, P.C. (Mitre Corp., McLean, VA). pp 78-95 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The methodology and baseline results of an analysis of the potential market penetration of solar heating and cooling in the United States are described. The METEK-HACOB model, and the data required to operate it, are described. Global economic assumptions are tabulted. A flow diagram is presented which depicts the market penetration methodology of the HACOB model for buildings. A sample calculation of the heat loss coefficient for a single family residence is presented. Predicted figures of merit and market penetration rates are tabulated.

56215 Solar energy development in the United States and the ERDA programme. Purple, R.A. pp 96-98 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The economic and societal impacts of several alternative energy futures for the United States are discussed. Three scenarios are developed utilizing a computer based energy model to calculate

the cost of each future energy source. The three scenarios discussed are termed reference, low demand and solar emphasis. These studies imply that as energy prices rise, solar energy will become cost competitive with nuclear and fossil fuels. President Carter's energy plan is dicsussed in relation to these three scenarios.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 56205

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 56210, 56212, 56952, 57188

56216 (AD-A—061956) **Low temperature fabrication of high efficiency silicon solar cells. Final technical report, February 1975-June 1978.** Kirkpatrick, A.R.; Minnucci, J.A.; Greenwald, A.C. (Spire Corp., Bedford, MA (USA)). Aug 1978. Contract F33615-75-C-2006. 86p. NTIS PC A05/MF A01.

This report describes the results of a program to develop ion implantation/pulsed energy processing for spacecraft solar cell applications. The approach involves employing pulsed electron beam technology to achieve processing parameters not previously possible by conventional furnace heat treatments. Optimization of the ion implanted solar cell structure was undertaken but not completed. Cells with efficiencies to 13.7% AMO were achieved using furnace annealing and to 12.9% AMO using pulsed electron beam annealing. Prospects for future development to higher efficiencies and for totally automated production are excellent. Experimental evidence suggests that the ion implanted, pulsed electron beam annealed solar cell may have better inherent tolerance to electron irradiation than similar diffused or furnace annealed implanted junction cells.

56217 (ANL/OEPM—78-3, pp 74-90) **Near-term applications of photovoltaic systems.** Palmer, R. (Lewis Research Center, Cleveland, OH). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

This slide presentation gives a brief discussion of the capability of the DOE/LeRC Photovoltaic Systems Test Facility (STF). Several applications of photovoltaic arrays are discussed and battery storage information is provided.

56218 (ANL/OEPM—78-3, pp 91-92) **Military applications for photovoltaic systems.** Faehn, D.D. (Army Mobility Equipment Research and Development Command, Fort Belvoir, VA). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

Some present-day military usage of solar cell power and attendant battery storage requirements is briefly discussed. Lower storage costs and long battery life are predicted to be economic necessities as solar cell costs are reduced in the near future.

56219 (ANL/OEPM—78-3, pp 93-105) **Redox flow cells and solar applications.** 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

The status and progress of the Redox Project is presented. The objective of the DOE-Redox flow cell development and demonstration project is to develop a redox system as a prototype of commercial systems. The basic physical characteristics of a redox flow cell is reviewed. Its advantages over conventional storage devices and applications in photovoltaic systems is discussed.

56220 (COO—4094-57) **Flywheel energy storage and conversion system for photovoltaic applications.** Millner, A.R. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1979. Contract EY-76-C-02-4094. 7p. (CONF-790854—3). Dep. NTIS, PC A02/MF A01.

From Mechanical and mag. energy storage contractor; Washington, DC, USA (19 Aug 1979).

Progress is described on a project to develop a flywheel energy storage unit for use with photovoltaics in residential or load center applications. The unit employs a high-efficiency permanent-magnet motor-generator and cycloconverter electronics to convert DC input to regulated AC output. It also tracks the maximum operating point of the solar array. Magnetic bearings are used to support the motor. The project includes fabrication of a scale model unit, scaling laws for residential and intermediate load center sizes, and worth and cost estimation. Fabrication of a subscale model is 75% complete. Scaling laws have been developed for components and user worth studies performed for this unit; manufacturing cost studies are in progress.

56221 (DOE/JPL—1012-30) **Environmental testing of Block III solar cell modules. Part I. Qualification testing of standard production modules.** Griffith, J.S. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Sep 1979. Contract EX-76-A-29-1012. 20p. Dep. NTIS, PC A02/MF A01.

The results of qualification tests of Block III solar modules are described. Block III was the third large-scale procurement of silicon solar cell modules made by the JPL Low-cost Solar Array Project; the qualification modules were delivered in 1978. Block III modules continue to show improvements over Block I and Block II modules. Cell cracking and delamination are less prevalent, and interconnect problems and electrical degradation from environmental testing are now rare.

56222 (DOE/JPL/954339—13) **Evaluation of selected chemical processes for production of low-cost silicon (Phase III). Silicon Material Task, Low-Cost Solar Array Project. Thirteenth quarterly progress report, October 1-December 31, 1978.** Blocher, J.M. Jr.; Browning, M.F. (Battelle Columbus Labs., OH (USA)). 15 Feb 1979. Contract NAS-7-100-954339. 27p. Dep. NTIS, PC A03/MF A01.

Refinements of the design of the 50 MT/year Experimental Process System Development Unit (EPSDU) have been made and competitive bids have been received from mechanical, electrical, and structural contractors. Emergency procedures have been defined to counter a variety of contingencies disclosed in operations and safety reviews. Work continues with the fluidized-bed model to define conditions under which useful segregation of large particles can be obtained. Experimental work with an electrolytic cell for zinc chloride disclosed no significant increase in power efficiency by steps taken to increase electrolyte circulation. On the basis of materials compatibility and permeability tests, 310 stainless steel was chosen for the shell of the fluidized-bed reactor and SiC-coated graphite for the liner. Experiments on the volatility of lead, iron, and cadmium at the ppM level in zinc at its boiling point are being continued with provisions being made to withdraw molten samples so as to avoid segregation on freezing, believed to be the cause of earlier discrepancies.

56223 (DOE/JPL/954355—4-T1) **Large area silicon sheet by EFG. Fourth quarterly report, October 1-December 31, 1978.** Wald, F.V. (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 1 Mar 1979. Contract NAS-7-100-954355. 94p. Dep. NTIS, PC A05/MF A01.

Crystal growth station no. 1 further explored displaced die concepts, along with some initial work on buckle characterization. Also, convective impurity redistribution was further studied. In particular, a side channel die was used to grow material doped with aluminum and compare the results at least semiquantitatively with computer calculations. The ribbons grown have not been characterized yet. In station no. 3A growth from single cartridges was continued to create a quality baseline to allow comparison of the results with those in the upcoming multiple run and to choose the most appropriate die design. Also fabrication and assembly work on the actual five ribbon furnace continued. On furnace 17 progress was made toward the development of the video optical system for edge position and meniscus height control. Also, in preparation for a detailed program, designed to explore the buckling problem, ribbon width ribon was then grown under stable conditions without a cold shoe, an achievement essential to finally arrive at quantitative correlations between growth conditions and buckle formation. The most significant result from the characterization program was a demonstration that the original runs with displaced dies were indeed reproducible, inasmuch as large area cells (7.5 x 7.5 cm^2) of ~ 9% efficiency could be fabricated again from run 18-103, a repeat of run no. 18-102 which had previously produced the best cells.

56224 (DOE/JPL/954560—8) **Synthesis of silane and silicon in a nonequilibrium plasma jet. Final report.** Calcote, H.F. (Aerochem Research Labs., Inc., Princeton, NJ (USA)). Oct 1978. Contract NAS-7-100-954560. 117p. Dep. NTIS, PC A06/MF A01.

The original objective of this program was to determine the feasibility of high volume, low-cost production of high purity silane or solar cell grade silicon using a nonequilibrium plasma jet. The emphasis was changed near the end of the program to determine the feasibility of preparing photovoltaic amorphous silicon films directly using this method. The nonequilibrium plasma jet is produced by partially dissociating hydrogen to hydrogen atoms in a 50 to 100 Torr glow discharge and expanding the H/H_2 mixture through a nozzle. A high flux density of hydrogen atoms is thus produced at concentrations of about 3 mol % with about 30% energy utilization efficiency. The jet is mixed with a second reactant and the reaction proceeds at a temperature of 400 to 600°K to produce products. Yields of SiH_4, $SiHCl_3$, or SiH_2Cl_2 from $SiCl_4$ and $SiHCl_3$ were too low to be economically attractive. However, both amorphous and polycrystalline silicon films which strongly adhered to Pyrex, Vycor, aluminum, or carbon were prepared with either $SiCl_4$ or $SiHCl_3$ reactants. Preliminary doping experiments with PH_3 did not alter the electrical resistivity of these films. Strongly adhering films with SiH_4 reactant were more difficult to prepare; they were prepared by carefully cleaning the aluminum substrate, diluting the SiH_4 with about 90% argon, and forming the glow discharge between the mixing nozzle and the aluminum substrate. Doping such films with P

by adding PH_3 reduced the electrical resistivity by two orders of magnitude. The nonequilibrium plasma jet should be further evaluated as a technique for producing high efficiency photovoltaic amorphous silicon films.

56225 (DOE/JPL/954587—1) **Large scale production task: low cost silicon solar array project. Final technical report.** (Spectrolab, Inc., Sylmar, CA (USA)). Sep 1978. Contract NAS-7-100-954587. 27p. Dep. NTIS, PC A03/MF A01.

Several design concepts were evaluated and compared with respect to potential for low cost and automation, protection against weathering, potential for array efficiency as a function of weight and area, potential for design flexibility and exposure to electrical breakdown or leakage to ground. This evaluation program narrowed attention to design concepts involving glass as the primary structural and weather resistant component of the module. The leading specific design structure consisted of the solar cell circuit embedded in polyvinyl butyrate by lamination between a glass front surface and a polyester film rear surface. Preliminary evaluation of this structure in high humidity and thermal cycle was promising, and extensive field experience with similar structures in architectural and automotive applications was favorable. The specific design proposed was comprised of 120 two-inch diameter cells in a series-parallel configuration. The laminate was mounted in an aluminum frame with a neoprene gasket providing the requisite mechanical strength with flexibility. The resulting module size of 15 by 46 inches permits three modules to be neatly fitted into the 46 inch square subarray specified by JPL. The design as modified to accommodate subsequent experience is shown. Performance and environmental test results are presented and discussed.

56226 (DOE/JPL/954873—5) **Phase 2 of the Array Automated Assembly Task for the Low Cost Solar Array Project. Quarterly report 5, October 1-December 31, 1978.** Campbell, R.B.; Page, D.J.; Rai-Choudhury, P.; Seman, E.J.; Hanes, M.H.; Rohatgi, A.; Davis, J.R. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 31 Jan 1979. Contract NAS-7-100-954873. 42p. Dep. NTIS, PC A03/MF A01.

Various top contact metal systems have been studied. Only Ti-Pd-Cu approaches baseline (Ti-Pd-Ag) quality, but this system shows a lack of long-term stability. Aluminum back surface field structures have been fabricated and thicknesses of p^+ material of up to 7.0 microns have been achieved with open circuit voltages of 0.59V. A general purpose ultrasonic welder has been purchased and tests using various metal foils are under way. During fabrication of the demonstration module, several cells became cracked. Due to redundancy of interconnections, the module was not open circuited but the efficiency was reduced to 8.8%. The broken cell was interconnected with a strap across the back and the efficiency was increased to 11.5%. A cost analysis (SAMICS) was made using a process sequence developed during Phase 1 of this contract. The results indicate a selling price of $0.56/watt peak (in 1986 with 1975 dollars).

56227 (DOE/JPL/954873—78/04) **Phase 2 of the array automated assembly task for the low cost solar array project. First annual report, October 1, 1977-October 30, 1978.** Campbell, R.B. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). 16 Nov 1978. Contract NAS-7-100-954873. 183p. Dep. NTIS, PC A09/MF A01.

A process sequence has been proposed and tested for the fabrication of dendritic web silicon into solar modules. This sequence has been analyzed as to yield and cost and these data suggest that the price goals of 1986 are attainable. A number of the processes that make up this sequence have been further developed and studied as to cost reduction. Specifically, it has been shown that a low cost $POCl_3$ is a suitable replacement for the semiconductor grade, and that a suitable CVD oxide (either doped or undoped) can be deposited from a silane/air mixture using a Silox reactor. A dip coating method has been developed for depositing an antireflection coating from a metal-organic precursor. Application of photoresist to define contact grids has been made cost effective through use of a dip coating technique. Electroplating of both Ag and Cu has been shown feasible and cost effective for producing the conductive metal grids on the solar cells. Laser scribing has been used to separate the cells from the dendrites without degradation. Ultrasonic welding methods have been shown to be feasible for interconnecting the cells. A study of suitable low cost materials for encapsulation suggest that soda lime glass and phenolic filled board are preferred.

56228 (DOE/JPL/954877—78/5) **Study program to develop and evaluate die and container materials for the growth of silicon ribbons. Quarterly report No. 5.** Ownby, P.D.; Yu, B.B.; Barsoum, M.W. (Eagle-Picher Industries, Inc., Miami, OK (USA). Miami Research Labs.). Jan 1979. Contract NAS-7-100-954877. 46p. Dep. NTIS, PC A03/MF A01.

Die and container material development efforts under the current program are shared among three organizations: Miami Research Laboratories (MRL) - ceramic process development and overall program management; University of missouri-Rolla (UMR) - silicon sessile drop studies with characterization of reaction products and emphasis on atmospheric effects; and Chemetal Corporation, Pacoima, California - special coatings to be applied to test coupons, die shapes, and containers provided by MRL and tested/characterized by UMR. The completion of a major hardware delivery milestone was accomplished with the delivery of three CNTD Si_3N_4 coated hot pressed Si_3N_4 crucibles to JPL. A limited characterization of the coating was performed at MRL prior to delivery. The coatings were fine grained α - Si_3N_4. It has been determined that a two piece die design will be required. At UMR the importance of the role of oxygen in influencing the attack of the CNTD materials by molten silicon has been demonstrated. The stability is greatly enhanced by maintaining the oxygen partial pressure near or below the $Si + O_2 = SiO_2$ equilibrium.

56229 (DOE/JPL/954901—5) **Development and evaluation of die materials for use in the growth of silicon ribbons by the inverted ribbon growth process. Task II. LSSA Project. Quarterly report No. 5, October 1-December 31, 1978.** Duffy, M.T.; Berkman, S.; Moss, H.I.; Cullen, G.W. (RCA Labs., Princeton, NJ (USA)). Dec 1978. Contract NAS-7-100-954901. 15p. Dep. NTIS, PC A02/MF A01.

Several ribbon growth experiments were performed in the Mark II ribbon growth facility from V-shaped dies coated with CVD Si_3N_4. The most significant result was the ability to perform five consecutive growth runs from the same die without mechanical degradation of the die through temperature cycling. The die was made from vitreous carbon coated with CVD Si_3N_4. Silicon oxynitride, Si_2N_2O, was examined with respect to thermal stability in contact with molten silicon. The results of x-ray analysis indicate that this material is converted to both α- and β-Si_3N_4 in the presence of molten silicon. The latter phase is the dominant phase. Experiments on the stability of CVD SiO/sub x/N/sub y/ show that this material can be maintained in contact with molten silicon (sessile drop test) for greater than 30 h at 1450°C without total decomposition. These layers are converted mainly to β-Si_3N_4. The fabrication of coated EFG-type dies is proving difficult because of thermal expansion mismatch between layer and substrate and instability of substrate materials at high temperature. Self-supporting CVD dies have been prepared on silicon substrates but the wall thickness is not greater than about 50 μm. Experiments are continuing.

56230 (DOE/JPL/955089—11) **Silicon solar cell process development, fabrication, and analysis. Second quarterly report, October 1-December 31, 1978.** Yoo, H.I.; Iles, P.A.; Tanner, D.P. (Optical Coating Lab., Inc., City of Industry, CA (USA). Photoelectronics Div.). 1978. Contract NAS-7-100-955089. 71p. Dep. NTIS, PC A04/MF A01.

RTR (ribbon-to-ribbon) solar cells (2 x 2 cm) processed from polycrystalline feedstock showed maximum AMO efficiency of 5.6%. Solar cells from single crystalline feedstock showed slightly higher efficiency than those from polycrystalline feedstock, indicating maximum efficiency of about 6.6% with SiO AR coating. Single crystalline control cells gave 11-12% AMO efficiencies demonstrating that the poor performance of the RTR solar cells was due to the low quality of material itself (this conclusion was backed up by the separate measurement of minority carrier diffusion length). Dendritic web solar cells (2 x 2 cm) from the standard process showed maximum AMO efficiency (with SiO AR coating) of 9.8% while efficiency of control solar cells were around 11-12%. Web solar cells from back surface field (BSF) process indicated maximum AMO efficiency of 10.9%. Some improvement in open circuit voltage was noticed from the BSF process. Small light spot scanning experiments were carried out on the solar cells from Wacker Silso, EFG, RTR, and dendritic web ribbons. Photoresponse results provided information on localized cell performance and grain size in polycrystalline material, and agreed quite well with the cell performance data, such as efficiency, minority carrier diffusion length, and spectral response.

56231 (DOE/JPL/955164—1) **Development of economical improved thick film solar cell contact. Quarterly report No. 1.** Ross, B.; Mentley, D. (Ross (Bernd) Associates, San Diego, CA (USA)). Jan 1979. Contract NAS-7-100-955164. 42p. Dep. NTIS, PC A03/MF A01.

Materials were surveyed to provide candidates for an all metal electrode paste system. These consisted of a major constituent metal powder, a low melting metal powder suitable for a liquid phase sintering medium, and a powder material suitable as an etchant for silicon dioxide at sintering temperatures. By means of thermal gravimetric analysis a suitable binder was identified for low temperature fired inks. The all metal ink concept was first demonstrated with the silver system to avoid the problems of limited process windows encountered with base metal systems. A number of solid materials capable of selectively etching silicon dioxide at modest temperatures were identified. One of these, silver fluoride, has yielded very good results, wetting the silicon surface after removing a thick (3000 A) silica layer. Silver pastes containing the above materials have been prepared. A paste with silver fluoride was screened onto N-type silicon with 5Ωcm resistivity. The resulting contact pads had excel-

lent adhesion but were not electrically ohmic. Another metal ink paste, incorporating boric acid, gave substantially lower resistances; however, it would not pass a 1-hour boiling DI water immersion without losing scratch resistance.

56232 (HEDL-SA—1704-FP) **Infrared NDT methods applied to solar cell and panel characterization.** Green, D.R.; Olsen, L.C. (Hanford Engineering Development Lab., Richland, WA (USA)). 20 Oct 1978. Contract EY-76-C-14-2170. 25p. Dep. NTIS, PC A02/MF A01.

Infrared nondestructive testing (NDT) methods are described that have a good potential for providing valuable data concerning solar cell or panel characteristics without requiring contact with the photovoltaic device. Preliminary tests with cells and panels were conducted and the infrared NDT results are presented and discussed. (MHR)

56233 (N—79-13501) **Parametric study of two planar high power flexible solar array concepts.** Garba, J.A.; Kudija, D.A.; Zeldin, B.; Costogue, E.N. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Dec 1978. Contract NAS7-100. 586p. NTIS PC A25/MF A01.

The design parameters examined were: frequency, aspect ratio, packaging constraints, and array blanket flatness. Specific power-to-mass ratios for both solar arrays as a function of array frequency and array width were developed and plotted. Summaries of the baseline design data, developed equations, the computer program operation, plots of the parameters, and the process for using the information as a design manual are presented.

56234 (N—79-13886) **Ionized dopant concentrations at the heavily doped surface of a silicon solar cell.** Weinberg, I.; Broder, J.D.; Mazaris, G.A. Jr.; Hsu, L. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Dec 1978. 19p. NTIS PC A02/MF A01.

Data are combined with concentrations obtained by a bulk measurement method using successive layer removal with measurements of Hall effect and resistivity. From the MOS (metal-oxide-semiconductor) measurements it is found that the ionized dopant concentration N has the value (1.4 + or - 0.1) x 10^{24} cu cm at distances between 100 and 220 nm from the n(+) surface. The bulk measurement technique yields average values of N over layers whose thickness is 2000 nm. Results show that, at the higher concentrations encountered at the n(+) surface, the MOS C-V technique, when combined with a bulk measurement method, can be used to evaluate the effects of materials preparation methodologies on the surface and near surface concentrations of silicon cells.

56235 (SAN—1250-2) **Research on lattice-mismatched semiconductor layers. Progress report No. 2, 16 August 1977-15 May 1978.** Moon, R.L. (Varian Associates, Inc., Palo Alto, CA (USA)). May 1978. Contract EY-76-C-03-1250. 57p. Dep. NTIS, PC A04/MF A01.

Investigations of the Al/sub x/Ga/sub 1-x/As/sub 1-y/Sb/sub y/ quaternary alloy have shown that compositions necessary for a two-junction stacked solar cell can be grown by LPE. Aluminum concentrations of 88 mole% have been grown in an alloy containing 16 mole% Sb. For a constant Al concentration in the solution, the addition of Sb causes Al incorporation in the solid to decrease. Antimony behavior is similar to that observed in the GaAsSb ternary system. Lattice constant grading using Al depletion to change As activity has been used to continuously grade from GaAs to $Al_{.01}Ga_{.99}As_{.84}Sb_{.16}$. Layers of $GaAs_{.84}Sb_{.16}$ have been routinely grown on the graded layer. The best orientation for combining good growth rate, surface morphology and solution removal has been the GaAs (111)A surface. Growth rates for the conditions used are in the order (100) > (111)A > (111)B. Etch-pit densities are normally $\geq 10^6$ cm^{-2} after grading and sometimes inhomogeneously distributed. Etch-pit studies during the early stages of growth suggest that dislocation bunching occurs at this stage. Tin doping of GaAsSb is shown to be dependent upon which side of the pseudobinary growth occurs. The net electron concentration for a given X/sub Sn//sup l/ is observed to be higher when growth is from an Sb-rich solution. Complete 1.15-eV solar cells consisting of $Al_{.6}Ga_{.4}As_{.85}Sb_{.15}$/GaAs $_{.84}Sb_{.16}$/graded AlGaAsSb/GaAs(111)A have been fabricated and tested. The maximum quantum efficiency in the cells tested to date has been 25%. GaAsSb p-n junctions with low leakage currents over areas as large as 0.68 cm^2 have been grown on continuously graded layers.

56236 (SAN—1458-5) **Cadmium sulfide/copper ternary heterojunction cell research. Final report, September 30, 1977-December 3, 1978.** Buldhaupt, L.F.; Mickelsen, R.A.; Chen, W.S.; Selikson, B. (Boeing Aerospace Co., Seattle, WA (USA)). Oct 1978. Contract EG-77-C-03-1458. 55p. Dep. NTIS, PC A04/MF A01.

The fabrication of cells on glazed alumina substrates entirely by vacuum deposition processes is described. Data presented for cells of 1 and 4 cm^2 in area demonstrates the achievement of conversion efficiencies of 5.7% and 2.3%, respectively, for a simulated light intensity of 100 mW/cm^2. The 1 cm^2 cells are shown to display an open-circuit voltage of 0.34V, short-circuit current of 31 mA/cm^2, fill-factor of 54%, diode A-factor of 2.0, and an improvement in performance following a mild heat treatment. $CuInSe_2$ film preparation using a simultaneous elemental evaporation process, which includes a heated vapor beam homogenization chamber for deposited film uniformity, is described. With a substrate temperature of 450°C, the deposition of large grain size (~ 1μm), P-type, single phase $CuInSe_2$ thin-films is reported. Co-evaporation of CdS and In is described for producing the low resistivity (0.003 ohm-cm) CdS films leading to low series resistance cells. The results of cell analysis using light and dark I-V and dark C-V measurements are reported and interpreted. Finally, a conceptual cell model and future projections regarding efficiency (11.6%) and high volume production costs (~ $40.00/kW) are discussed.

56237 (SAN—1459-5) **Cadmium sulfide/copper sulfide heterojunction cell research. Final report, September 30, 1977-October 31, 1978.** Anderson, W.W.; Jonath, A.D.; Thornton, J.A. (Lockheed Palo Alto Research Labs., CA (USA)). Nov 1978. Contract EG-77-C-03-1459. 77p. Dep. NTIS, PC A05/MF A01.

A multicathode deposition system has been brought into operation and used to deposit multilayer films of Cu/sub x/S/CdS/Nb in a single pumpdown. In addition, it has been used to prepare In-doped CdS films by cosputtering of Cd and In. Analysis of the photovoltaic devices deposited in the system to date have determined the areas requiring further development. Electrical, optical, and structural measurements on all components of the multilayer films have been carried out and related to the corresponding deposition parameters. The theory of reactive sputter deposition of compound semiconductors has been developed to explain the rate limiting deposition processes and the ease with which a stoichiometric compound is formed. Copper sulfide coatings about 0.15-μm thick were deposited by reactive sputtering from a copper cylindrical-post magnetron sputtering source in an Ar-H_2S atmosphere. The coating resistivity increased by more than six orders of magnitude with increasing H_2S injection rate. However, above a critical injection rate the resistivity data indicate two types of materials: a high-resistivity type (~ 100 Ω-cm) often exhibiting Cu-rich surface nodules, and a low-resistivity type (~ zero Ω-cm). Hall mobilities were in the 1 to 6 cm^2/V-s range for both materials. Optical absorption, resistivity-versus-temperature, and x-ray diffraction measurements indicate that the high resistivity material consists largely of near stoichiometric, chalcocite, possibly stabilized by the excess copper and that the low resistivity material is a mixture of chalcocite and djurleite. Resistivity of CdS and Cd/sub 1-x/Zn/sub x/S films could be controlled by In doping. The all-vacuum photovoltaic junctions deposited to date have displayed V/sub oc/ ≈ 0.3 V.

56238 (SAN—1577-4) **Cadmium sulfide/copper sulfide heterojunction cell resea .h. Technical progress report No. 4, July 1-September 30, 1978.** Szedon, J.R.; Shirland, F.A.; Biter, W.J.; Stoll, J.A.; Dickey, H.C.; O'Keeffe, T.W. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 20 Nov 1978. Contract EG-77-C-03-1577. 86p. Dep. NTIS, PC A05/MF A01.

Important advances have been made in five technical areas during this quarter: topological investigations of film materials and cells, characterization of current transport and collection in Cu_2S/CdS cells, preparation and application of small area film cells, correlation of photoresponse image and structural features in film cells and means of preparing (CdZn)S alloy films. The use of potassium cyanide etching of Cu_2S layers on polycrystalline CdS films defined areas 1 to 5 μm across with the latter covering 30 to 50% of the surfaces studied. Large grains may strongly reduce short circuit current levels. Laser scanned photocurrent response of tapered Cu_2S layers on single crystal CdS has been refined to directly treat photocurrent-transmission data, allowing more firm estimates of lifetime, surface recombination velocity and heterojunction collection efficiency. Delineation of small area film cells has been done successfully using photolithographic methods. As used, these methods have no deleterious influence on cell behavior. With arrays of small cells on a single substrate it was possible to establish that increased junction opposing current (lower V/sub OC/) results from longer immersions in CuCl during Cu_2S formation. Patterns of high response in laser-scanned photocurrent images have been correlated with SEM images of grain boundary patterns. Difficulties in the use of a quadrupole mass analyzer to monitor component fluxes during (ZnCd)S evaporation were isolated and overcome, allowing use of the method to prepare films for structural, electrical, and cell evaluation.

56239 (SERI/TP—69-276) **Proceedings: photovoltaics user review panel. March 6 and 7, 1979.** Carroll, S. (Solar Energy Research Inst., Golden, CO (USA)). Aug 1979. Contract EG-77-C-01-4042. 27p. (P). Dep. NTIS, PC A03/MF A01.

The discussions, recommendations, and conclusions of the Photovoltaics User Review Panel are presented. The purpose of the panel discussions was to determine the Technical Information Dissemination (TID) needs for target audiences, to reach agreement on what informational products could fill these needs and who should

produce the materials, and to establish priorities for the need for the TID products.

56240 (SERI/TR—52-250) **Objectives and strategies of the International Photovoltaic Program Plan.** Costello, D.; Posner, D.; Koontz, R.; Heiferling, P.; Carpenter, P.; Perelman, L. (Solar Energy Research Inst., Golden, CO (USA); Jet Propulsion Lab., Pasadena, CA (USA)). Jul 1979. Contract EG-77-C-01-4042. 43p. Dep. NTIS, PC A03/MF A01.

The Solar Photovoltaic Energy Research, Development, and Demonstration (RD and D) Act of 1978 calls for the Secretary of the US Department of Energy (DOE) to prepare a plan to demonstrate photovoltaic systems in other nations and to facilitate the widespread use of these systems. The objective of the International Photovoltaic Program Plan, the strategies that will be used in the plan, and the approach that is being taken to prepare the plan are described. Background on photovoltaic technology and markets and the DOE domestic photovoltaic effort is also provided. The International Photovoltaic Program Plan will complement the DOE domestic activities to stimulate international markets. A number of national and international benefits could result if the objective of accelerating the widespread use of photovoltaic systems in international markets is realized. A primary benefit is that foreign markets may help stabilize the US photovoltaic industry and foster its expansion. Other benefits include contributions to the advancement of developing countries, reductions in world oil imports, and improvements in the US balance of trade. Strategies to be addressed in the plan are photovoltaic system demonstrations, systems development, information gathering and dissemination, financial incentives, and administrative actions. A critical aspect of the plan will be the coordination of selected programs and the monitoring and assessment of the plan's results. Analyses of international markets, international financial institutions, foreign competition, international marketing experiences of other US industries, and system development needs have been initiated to support the plan.

56241 **Antireflection properties of indium tin oxide (ITO) on silicon for photovoltaic applications.** Cheek, G.; Genis, A.; DuBow, J.B.; Verneker, V.R.P. (Colorado State University, Department of Electrical Engineering, Fort Collins, Colorado 80523). *Appl. Phys. Lett.;* 35: No. 7, 495-497(1 Oct 1979).

The short-circuit current density (J/sub sc/) of indium tin oxide (ITO/silicon solar cells has been shown both theoretically and experimentally to be a function of the thickness of the ion beam sputtered ITO layer. These results can be accounted for by computing the optical reflection from the ITO/silicon interface.

56242 **Schottky barrier amorphous silicon solar cell with thin doped region adjacent metal Schottky barrier.** Carlson, D.E.; Wronski, C.R. (to RCA Corp.). US Patent 4,163,677. 7 Aug 1979. Filed date 28 Apr 1978. 6p.

A Schottky barrier amorphous silicon solar cell incorporating a thin highly doped p-type region of hydrogenated amorphous silicon disposed between a Schottky barrier high work function metal and the intrinsic region of hydrogenated amorphous silicon is described. The high work function metal and thin highly doped p-type region forms a surface barrier junction with the intrinsic amorphous silicon layer. The thickness and concentration of p-type dopants in said p-type region are selected so that said p-type region is fully ionized by the Schottky barrier high work function metal. The thin highly doped p-type region has been found to increase the open circuit voltage and current of the photovoltaic device.

56243 **Cost factors in photovoltaic energy conversion with solar concentration.** Parott, J.E. (UWIST, Cardiff, England). pp 49-53 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

A simple model for analyzing the economics of concentrating solar systems, as opposed to flat-plate systems, is discussed. Three factors are identified as being of importance to make concentrators successful: (1) the cost of the concentrator must be much less than that of the solar cell; (2) the climatic factors must be favorable both absolutly and compared to flat plates; (3) the efficiency must be good at high solar flux intensity. The cost and concentration ratio for several concentrators are tabulated. After a brief discussion of three types of solar cells considered for use in concentration systems, a cost estimate of $0.04/kWhr is obtained. Under desert conditions with no available power from central stations, it is concluded that a concentrator photovoltaic system is competitive.

56244 (DOE/JPL/954689—4) **Metallization of large silicon wafers. Final report.** Pryor, R.A. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). [nd]. Contract NAS-7-100-954689. 137p. Dep. NTIS, PC A07/MF A01.

A metallization scheme has been developed which allows selective plating of silicon solar cell surfaces. The system is comprised of three layers. Palladium, through the formation of palladium silicide at 300°C in nitrogen, makes ohmic contact to the silicon surface. Nickel, plated on top of the palladium silicide layer, forms a solderable interface. Lead-tin solder on the nickel provides conductivity and allows a convenient means for interconnection of cells. To apply this metallization, three chemical plating baths are employed. Palladium is deposited with an immersion palladium solution and an electroless palladium solution, and nickel is deposited with an electroless nickel solution. Solder is applied with a molten solder dip. Extensive development work has been performed to achieve an effective immersion palladium solution formulation, leading to reproducible formation of the palladium silicide contact layer. This metallization system has been repeatedly demonstrated to be extremely effective. Current-voltage characteristic curve fill factors of 78% are easily achieved. This has been done while maintaining metal contact adhesion at such a strength as to fail by fracturing silicon upon perpendicular pull testing rather than be delaminating the metal system. Process specifications and procedures have been prepared.

56245 (COO—4094-26) **Solar photovoltaic field tests and applications project. Quarterly technical report, April 1-June 30, 1978.** (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). [nd]. Contract EY-76-C-02-4094. 57p. Dep. NTIS, PC A04/MF A01.

Field tests for a variety of both large and small experimental photovoltaic systems are summarized. Support activities in the areas of power conditioning, control, and storage; materials, processes, and testing; and data acquisition are reviewed. (MHR)

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 56782, 56817

56246 (CONF-7905101—1) **Barriers to commercialization of biomass energy technology.** Klass, D.L. (Institute of Gas Technology, Chicago, IL (USA)). 1979. 6p. Inst. of Gas Technology, Chicago, IL.

From Mid-American biomass energy workshop; West Lafayette, IN, USA (21 May 1979).

The following barriers are discussed: the excessive cost of biomass-derived synfuels, negative net energy production efficiency, the all or nothing at all syndrome, government regulations and resistance to change, low profitability of multi-product plants, and too much undirected research. (MHR)

56247 (DOE/CS/5912—T1) **Production of sugarcane and tropical grasses as a renewable energy source. Second quarterly report; year 2, 1978-1979.** Alexander, A.G.; Garcia, M.; Gonzalex-Molina, C.; Ortez-Velez, J. (Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station). 1979. Contract ET-78-S-05-5912. 62p. Dep. NTIS, PC A04/MF A01.

Research centered on greenhouse screening of candidate grasses coupled with field-plot studies on varieties, optimal nitrogen and seeding rates, variable row spacing, and frequency of harvest. Candidate grasses were identified for short-rotation crops having potentially greater versatility than Sordan 70A (earlier maturatoon greater tolerance to moisture stress). Field-plot studies were performed on the optimization of N-fertilization and seeding rates for Sordan 70A. Field-plot data were recorded on sugarcane and napier grass responses to harvest frequency and row spacing. These results underscore a superiority of first-ratoon yields over plant-crop yields, of napier grass over sugarcane (up to 4 months), and delayed harvests over frequent harvests. Breeding tests were successful in producing F_1 seedlings from crosses between an unknown and early-tasseling wild S. spontaneum hybrid and late-tasseling commercial sugarcane hybrids.

56248 (INKA-Conf—78-226-000) **Agriculture and energy.** (Dachverband Wissenschaftlicher Gesellschaften der Agrar-, Forst-, Ernaehrungs-, Veterinaer-, und Umweltforschung e.V., Muenchen (Germany, F.R.)). 1978. 29p. (In German). (CONF-7811134—(Absts.)). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Lecture meeting on agriculture and energy; Muenchen, F.R. Germany (6 Nov 1978).

Seven papers deal with energy conversion in different fields of agricultue. Nine further papers deal with energy conservation and the exploitation of alternative energy sources on the agricultural sector.

56249 (SAN—115/141-3) **Preparation of a cost data bank for DOE/biomass energy systems branch. Third quarterly progress report, April 1-June 30, 1979.** Kam, A.Y.; Dickenson, R.L.; Jones, J.L.; Chatterjee, A.K.; Wilhelm, D.J. (SRI International, Menlo Park, CA (USA)). 1979. Contract EY-76-C-03-0115-141. 28p. (SRI-P—7885). Dep. NTIS, PC A03/MF A01.

This study deals with the preparation of a biomass conversion technology and cost data bank for the Biomass Energy Systems Branch (BES) of DOE/Solar. When completed, it may be used with an appropriate methodology to analyze the complex issues of research program planning and analysis. In addition, future market

penetration of BES products may be projected, and the options available to the federal government to influence the outcome of BES products marketing may also be examined. A total of 21 biomass conversion technology options (13 thermochemical and 8 biochemical) have been selected for inclusion in the data bank. These options cover the production of electric power, steam, gases, liquids, and solid fuels from biomass. The majority of the options are believed to be available now or in the near term. A consistent methodology for construction of the data bank has been developed. For each option, the most up-to-date process/product data are gathered and analyzed. A base case is established to generate estimates for plant investments required, operating cost, and product cost. The estimates are then examined systematically to identify and quantify the uncertainties. The uncertainties are combined using statistical methods to produce error band estimates. Technical and economic analysis has been completed for the following options: power generation, steam generation, co-generation, liquids from pyrolysis, densification, and ethanol from wood. Among the options nearing completion are catalytic liquefaction, medium-Btu gas, low-Btu gas, methanol, ethanol from sugar crops, and ethanol from corn. The available results are summarized.

56250 (SERI/RR—52-324) **Soil fertility and soil loss constraints on crop residue removal for energy production.** Flaim, S. (Solar Energy Research Inst., Golden, CO (USA)). Jul 1979. Contract EG-77-C-01-4042. 48p. Dep. NTIS, PC A03/MF A01.

A summary of the methodologies used to estimate the soil fertility and soil loss constraints on crop residue removal for energy production is presented. Estimates of excess residue are developed for wheat in north-central Oklahoma and for corn and soybeans in central Iowa. These sample farming situations are analyzed in other research in the Analysis Division of the Solar Energy Research Institute.

56251 (SHG-IST—2) **Wood fuels in the area around Mora, Sweden.** Soederqvist, A. (Skogshoegskolan, Garpenberg (Sweden). Inst. foer Skogsteknik). Feb 1979. 46p. (In Swedish). (NE-PROJ—3065151). Dep. NTIS (US Sales Only), PC A03/MF A01.

The aim of this report is to analyze the possibilities for using an area around Mora, Sweden, with a radius of 50 km for development and demonstration of the possibilities to utilize wood and wood wastes for the energy supply within a larger area. Future experiments within this area concerning the supply, transport, storage, and consumption of wood fuels are pointed out as well.

56252 **Biomass conversion potential in the southeast.** Saha, H. (Alabama A and M Univ., Huntsville). pp 481-488 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

A review of the biomass production and conversion potential of the Southeastern United States is presented. This region, with its large forest land and wood residue, long coastal areas, abundance of water, large amounts of readily collectable agricultural, urban and industrial waste materials, longer growing season, ample rainfall and fertile soil, is a natural resource area of renewable biomass energy. Different types of biomass production and conversion methods are elaborated and evaluated. One of the most promising systems to produce large quantities of biomass in this area is the establishment of intensively-managed energy farms, using woody and herbaceous species including forest and crop residues, high-yield crops, and animal manures. The programs for conversion of municipal and industrial wastes (solid and liquid) should also be considered for this region. One of the objectives should also be to develop the capability of utilizing readily available natural biomass resources in the Southeast for conversion into clean fuels, petrochemical substitutes, and other energy-intensive products.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

56253 (DSE—4042-T1) **Electrochemical photovoltaic cells. Project 65021 quarterly technical progress report, April 15-July 15, 1979.** Ang, P.G.P.; Sammels, A.F. (Institute of Gas Technology, Chicago, IL (USA)). Jul 1979. Contract EG-77-C-01-4042. 34p. Dep. NTIS, PC A03/MF A01.

The necessary equipment for evaluation of candidate photoelectrochemical systems has been assembled. Preliminary experimental work has been initiated on the following semiconductor materials: CdS, CdSe, CdTe, GaAs, and $MoSe_2$. Single crystals of $MoSe_2$ have been evaluated in alkaline as well as acid electrolyte in the presence of a variety of redox couples. Large photocurrents of about 10 to 20 mA/cm^2 have been observed under illumination with Xenon light (200 mW/cm^2) in the presence of I^-/I_2, Br^-/Br_2, Cu^{+1}/Cu^{+2}, and Sn^{+2}/Sn^{+4} in the electrolyte. Only small photocurrents of about 1 mA/cm^2 were seen when the electrolyte contained Sb^{+3}/Sb^{+5} or Fe^{+2}/Fe^{+3} redox couple. Work has been initiated on the photoelectrochemical properties of polycrystalline materials. Polycrystalline materials were fabricated in the laboratory using vacuum evaporation, sputtering, and electrodeposition techniques. Satisfactory CdSe and CdS photoelectrodes have been fabricated in this way. Heat treatment appears to be a critical step in improving the performance of these electrodes. Preliminary chemical corrosion tests on GaAs, GaP, CdSe, CdTe, $MoSe_2$, and MoS_2 were performed in alkaline and acid electrolytes. Materials that appeared stable after this test were then subjected to a photoelectrochemical corrosion test in electrolyte containing a variety of redox couples. The solid electrolytes, $RbAg_4I_5$ and $Na_2O.11Al_2O_3$, have been obtained. Photocurrents and photopotentials have been observed in cells of configuration iron oxide, PbI_2, $RbAg_4I_5/RbAg_4I_5/C$, PbI_2, and $RbAg_4I_5$.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 56210

56254 (ANL/OEPM—78-3) **Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.** Yao, N.P.; Barghusen, J.J. (eds.). (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 228p. Dep. NTIS, PC A11/MF A01.

The purpose of the workshop was to provide a forum for discussion of current experience in and plans for solar-photovoltaic systems in order to define the role of battery storage in various solar-photovoltaic applications. Ten invited papers are individually abstracted.

56255 (ANL/OEPM—78-3, pp 3-36) **Summary of application analysis for photovoltaic systems.** Jones, G.J.; Watkins, J.L. (Sandia Labs., Albuquerque, NM). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

A summary of the work that has been done in the area of photovoltaic systems analysis as well as a description of current and planned activities, is presented. Important conclusions and unresolved issues are discussed in terms of five application sectors: remote applications, residential systems, service/commercial/institutional and industrial applications, agricultural applications, and central power applications. The results of the studies to date indicate cost effectiveness of consumer-owned photovoltaic systems in many regions in 1986 and everywhere by 2000, providing DOE price goals are met. The greatest general area of uncertainty in all sectors is the utility-customer interface for consumer owned systems, and the worth of the photovoltaic system to the utility for utility owned systems.

56256 (ANL/OEPM—78-3, pp 37-62) **Battery performance requirements for terrestrial solar photovoltaic power systems.** Stolte, W.J. (Bechtel Corp., San Francisco, CA). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

The purpose of this study was to identify the characteristics required of batteries in photovoltaic power systems as a basis for the timely development of suitable batteries. A broad spectrum of terrestrial photovoltaic applications were evaluated in general by considering the types of loads served and the characteristics of system components. Four applications, representative of low, intermediate and high power systems, were examined in detail. The desired characteristics for the batteries, based on the postulated photovoltaic system application, were determined, and an economic analysis of allowable battery break-even costs was conducted.

56257 (ANL/OEPM—78-3, pp 63-73) **Photovoltaic projects at MIT Lincoln Laboratory.** Matlin, R.W.; Sacco, S.B. (Massachusetts Inst. of Tech., Lexington). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

During FY-77 two photovoltaic projects at MIT Lincoln Laboratory became operational. These were the irrigation experiment at Mead, Nebraska, and the energy conversion exhibit at the Chicago Museum of Science and Industry. A rooftop array and test area was also begun and is now being enlarged. These experiments are described and plans for activities during FY-78 are discussed.

56258 (ANL/OEPM—78-3, pp 126-142) **Impact of solar-photovoltaic systems on electric utilities.** May, J.P. (National Economic Research Associates, Inc., New York, NY). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

The economic impact of interfacing the emerging solar technology with existing energy systems such as the electric utility industry is emphasized. The economic trade-off between the storage capacity required as a back-up heating system and the extent of its use is considered from both the users' and electric utility's viewpoints.

56259 (ANL/OEPM—78-3, pp 143-170) **Estimating the present worth of photovoltaic systems to a utility.** Goodman, F.R. Jr. (Los Angeles Dept. of Water and Power, CA). 1978.

In Proceedings of the workshop on battery storage for solar-photovoltaic energy systems.

An attempt is made to show how conventional utility tools for power generation planning can be adapted to assess the value of photovoltaic power plants to an electric utility. A modified Loss of Load Probability (LOLP) methodology and requisite assumptions for determining system reliability, allowable effective capacity, and production costs are discussed. Some factors that influence effective capacity are discussed: plant design, site location, component reliability, the percentage of the total generation capacity attributable to photovoltaic power plants, and availability of energy storage. (LS)

56260 (N—79-13263) **Microwave power transmitting phased array antenna research project. Summary report.** Dickinson, R.M. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Dec 1978. Contract NAS7-100. 94p. NTIS PC A05/MF A01.

An initial design study and the development results of an S band RF power transmitting phased array antenna experiment system are presented. The array was to be designed, constructed and instrumented to permit wireless power transmission technology evaluation measurements. The planned measurements were to provide data relative to the achievable performance in the state of the art of flexible surface, retrodirective arrays, as a step in technically evaluating the satellite power system concept for importing to earth, via microwave beams, the nearly continuous solar power available in geosynchronous orbit. Details of the microwave power transmitting phased array design, instrumentation approaches, system block diagrams, and measured component and breadboard characteristics achieved are presented.

56261 (SAN—1101/PA8-10) **Overview of photovoltaic market studies.** Rattin, E.J. (Aerospace Corp., El Segundo, CA (USA). Energy and Transportation Div.). May 1978. Contract EY-76-C-03-1101-008. 83p. (ATR—78(7694-05)-1). Dep. NTIS, PC A05/MF A01.

A summary of the results of recent studies sponsored by DOE and dealing with potential photovoltaic terrestrial solar energy systems markets is presented. Quantitative data developed by these studies are summarized to assist in planning test and applications programs and in estimating the level of photovoltaic system production capacity required to meet future market needs. Near-term (1976-1985) and mid-term (1986-2000) markets are discussed.

56262 (SAN—1101/PA8-11) **Photovoltaic central power plants. Some new evaluations on the basis of revised insolation data.** Leonard, S.L. (Aerospace Corp., El Segundo, CA (USA). Energy and Resources Div.). Jul 1978. Contract EY-76-C-03-1101-008. 57p. (ATR—78(7694-04)-3). Dep. NTIS, PC A04/MF A01.

A comparison of plant performance and cost-effectiveness as computed with two insolation data bases is presented. Three different collector/concentrator concepts (flat peak, north-south parabolic trough, and central receiver) and operation at four locations were evaluated. It is concluded that recent revisions in the insolation data base do not significantly change earlier evaluations of flat-plate photovoltaic plants but result in significantly less optimistic projections of cost-effectiveness of concentrator photovoltaic systems.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 56260

56263 (DOE/JPL/1060—14) **Assessment of the potential of solar thermal small power systems in small utilities. Final report.** Steitz, P.; Mayo, L.G.; Perkins, S.P. Jr. (Burns and McDonnell Engineering Co., Kansas City, MO (USA)). Nov 1978. Contract EX-76-A-29-1060. 228p. Dep. NTIS, PC A11/MF A01.

This study involved an assessment of the potential economic benefit of small solar thermal electric power systems to small municipal and rural electric utilities. Five different solar thermal small power system configurations were considered in the study representing three different solar thermal technologies. The configurations included: (1) 1-MW, 2-MW, and 10-MW parabolic dish concentrators with a 15-kW heat engine mounted at the focal point of each dish. These systems utilized advanced battery energy storage. (2) A 10-MW system with variable slat concentrators and central steam Rankine energy conversion. This system utilized sensible thermal energy storage. (3) A 50-MW central receiver system consisting of a field of heliostats concentrating energy on a tower-mounted receiver and a central steam Rankine conversion system. This system also utilized sensible thermal storage. The approach used in determining the potential for solar thermal small power systems in the small utility market involved a comparison of the economics of power supply expansion plans for seven hypothetical small utilities through the year 2000 both with and without the solar thermal small power systems. Insolation typical of the Southwestern US was assumed. A comparison of the break-even capital costs with the range of plant costs estimated in this study yields the following conclusions: (1) The parabolic dish concentrator systems could be economically competitive with conventional generation if the lowest capital costs can be achieved. (2) The variable slat concentrator and central receiver systems would have to achieve lower costs than the lowest in the cost ranges generally assumed in the study to become economically competitive. (3) All of the solar thermal plant types are potentially more competitive in utilities which are heavily dependent upon oil.

CENTRAL RECEIVER

56264 (ANL—79-33) **Biaxial creep-fatigue behavior of Type 316H stainless steel tube.** Majumdar, S. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 33p. Dep. NTIS, PC A03/MF A01.

Biaxial creep-fatigue test data for Type 316 stainless steel tubes at 1100°F for use in high-temperature components in solar central receivers are presented. The specimens were subjected to constant internal pressure and fluctuating axial strain with and without hold times in tension as well as compression. The results show that internal pressure significantly affects diametral ratchetting and axial stress range. Axial tensile hold is found to be more damaging than axial compressive hold even under a biaxial state of stress.

56265 (SAND—79-1730C) **Solar Central Receiver Test Facility.** Brandvold, G.E.; Holmes, J.T. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 18p. (CONF-790924—1). Dep. NTIS, PC A02/MF A01.

From Frontiers of power generation conference; Stillwater, OK, USA (24 Sep 1979).

The world's largest high intensity solar experimental facility became fully operational October 1978. The Central Receiver Test Facility is capable of delivering 5 million watts of thermal power to experimental equipment. The primary CRTF testing programs will involve prototype components (receivers and heliostats) for central receiver solar electric power plants. The CRTF also provides unique capabilities for other high solar flux and high temperature research and development work. Two hundred twenty-two sun tracking heliostats are used to concentrate the sun's energy to an experiment located on the 61 meter tall concrete tower. Testing of the first gas cooled receiver was completed in March 1979. The first steam cooled receiver and prototype power plant heliostats are currently under test at the CRTF.

56266 (SAND—79-8632) **Sandia Laboratories Materials Task Group review of the 10-MW/sub e/ Barstow pilot plant conceptual design.** Bartel, J.J.; Gerstle, F.P. Jr.; Mar, R.W.; Rack, H.J.; Robinson, S.L.; Wischmann, K.B. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

A Sandia Materials Task Group reviewed the 10-MW/sub e/ Barstow solar central receiver pilot plant design. No major problems were identified; additional work in several areas is suggested to resolve potential concerns. A Materials Review Tabular Summary and supporting text description have been prepared for each subsystem-receiver, storage and heliostats.

DISTRIBUTED COLLECTOR

56267 (DOE/JPL—1060-16) **Preliminary assessment of small steam Rankine and Brayton point-focusing solar modules.** Roschke, E.J.; Wen, L.; Steele, H.; El Gabalawi, N.; Wang, J. (Jet Propulsion Lab., Pasadena, CA (USA); National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1 Mar 1979. Contract EX-76-A-29-1060. 141p. Dep. NTIS, PC A07/MF A01.

A preliminary assessment of three conceptual point-focusing distributed solar modules is presented. The basic power conversion units consist of small Brayton or Rankine engines individually coupled to two-axis, tracking, point-focusing solar collectors. An array of such modules can be linked together, via electric transport, to form a small power station. Each module also can be utilized, on a stand-alone basis, as an individual power source. The technical evaluation and economic analysis are treated separately. Each system concept was optimized by maximizing the thermal output per unit of concentrator area. System performance was then simulated based on the insolation data recorded at Barstow, California (in 1976). Parametric studies concerning concentrator quality and power conversion efficiency were conducted to provide relevant sensitivity relationships and trade-off information. Hardware cost targets were assessed according to the system energy production rate (kWe-hr/yr), and a range of projected energy cost levels (mills/kWe-hr). The trade-off relationship can be utilized as a realistic guideline for establishing concentrator manufacturing requirements and power conversion de-

velopment targets. The justified capital cost of small (15 kWe output) gas Brayton systems at 816°C (1500°F) and steam Rankine systems at 538°C (1000°F) has been compared for a range of energy cost values. The results obtained indicate that the Brayton system merits a higher capital cost than the Rankine system for an energy cost target of 50 mills/kWe-hr, if the concentrator quality is in the range of 1 to 4 mrad.

56268 (DOE/JPL—1060-25) **Application of field-modulated generator systems to dispersed solar thermal electric generation.** Ramakumar, R.; Bahrami, K. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Aug 1979. Contract EX-77-A-29-1060. 91p. Dep. NTIS, PC A05/MF A01.

A Parabolic Dish-Electric Transport concept for dispersed solar thermal generation is considered. In this concept the power generated by 15 kWe Solar Generation Units is electrically collected in a large plant. Various approaches are possible for the conversion of mechanical shaft output of the heat engines to electricity. This study focuses on the Application of Field Modulated Generation System (FMGS) for that purpose. Initially the state-of-the-art of FMGS is presented, and the application of FMGS to dispersed solar thermal electric generation is investigated. This is followed by the definition of the control and monitoring requirements for solar generation system. Then comparison is made between FMGS approach and other options. Finally, the technology developmental needs are identified.

56269 (SAND—79-1425) **Maximum field size for dispersed solar thermal power systems.** McCulloch, W.H. (Sandia Labs., Albuquerque, NM (USA)). Aug 1979. Contract EY-76-C-04-0789. 14p. Dep. NTIS, PC A02/MF A01.

Although thermal losses through the interconnecting field piping of dispersed solar thermal power systems become larger as the systems themselves are made larger, an analysis shows that this energy loss will not compromise the viability of the systems. Considerations other than thermal loss in interconnecting piping are more likely to limit the sizes of collector fields in such solar energy systems.

OCEAN THERMAL GRADIENT POWER PLANTS

56270 (ANL/OTEC-PS—2) **OTEC performance tests of the Union Carbide enhanced-tube condenser.** Yung, D.T.; Hillis, D.L.; Lorenz, J.J.; Sather, N.F. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 33p. Dep. NTIS, PC A03/MF A01.

Results of performance tests conducted on a Union Carbide enhanced-tube condenser with wire wrapping on the ammonia side and internal axial fins on the water side are reported. This unit performed satisfactorily and was free of operational difficulties. At design operating conditions (a heat duty of 3.2 million Btu/h, an inlet water temperature of 40°F, and a water flow rate of 3200 gpm) the steady-state value of the overall heat transfer coefficient was found to be 818 Btu/h.ft².°F, and the ammonia-side and water-side heat transfer coefficients were 5180 and 1130 Btu/h.ft².°F, respectively. The water-side pressure drop was 1.8 psi. Varying the heat duty from 2.4 million to 4.0 million Btu/h had a negligible effect on thermal performance. The value obtained for the ammonia-side heat transfer coefficient at nominal conditions is about two times that predicted by the Nusselt expression for condensation on a smooth tube. The water-side coefficient is within 3% of the value predicted by the Noranda correlation for finned tubes.

56271 **Vapor/liquid interaction and entrainment in shell-and-tube evaporators.** Yung, D.; Lorenz, J.J.; Ganic, E.N. (Argonne natl Lab, Ill). *Am. Soc. Mech. Eng.*, [*Pap.*]: No. 78-WA/HT-35, 1-10(1978).

The problem of vapor/liquid interaction and entrainment in shell-and-tube evaporators is analyzed. Attention is focused primarily on the horizontal tube falling film evaporators, which have been proposed for use in Ocean Thermal Energy Conversion (OTEC) power plants. In the horizontal tube design, liquid falls from one tube to the next in either a droplet or column mode. A criterion is derived for predicting the transition from the droplet mode to the column mode. Models are developed for predicting the deflection of droplets and columns due to vapor crossflow. Based on an experimental study of drop detachment and breakup, a correlation is established for determining the results of droplet sizes. For high vapor crossflow velocities, a criterion is presented for predicting the inception of liquid entrainment by a process known as stripping. Based on the foregoing models, conditions are defined under which vapor/liquid interaction and entrainment are important for OTEC evaporators.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 56203, 56206, 56209, 56211, 56305, 56308, 56764, 56861

56272 (ASHRAE/GRP—170) **Applications of solar energy for heating and cooling of buildings.** Jordan, R.C.; Liu, B.Y.H. (eds.). (American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., New York). 1977. Contract ET-78-C-01-3294. 207p. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 345 E. 47th Street, New York, NY $8.00.

This report contains thirteen individually abstracted articles dealing with the assessment of solar energy systems, solar system components and performance, and applications to heating and cooling.

56273 (COO—4495-7) **Solar-MEC development program. Project 9103 semiannual progress report, September 1, 1977-February 28, 1978.** Wurm, J.; Weil, S.A.; Wright, L.R. (Institute of Gas Technology, Chicago, IL (USA)). Jan 1979. Contract EG-77-C-02-4495. 45p. Dep. NTIS, PC A03/MF A01.

Progress on the development of the Solar-MEC desiccant cooling system is reported. Specifically, the dynamic performance of a supported molecular-sieve, regenerative, heat and mass exchanger is reported, under input conditions typical of the operation of a solar-powered open desiccant cooling system. Comparisons of the above experimental data with a computer model describing the dynamic processes of air drying and desiccant regeneration of the Solar-MEC desiccant cooling system are reported. An account of the test setup, of the experimental program, and the results of diagnostic steps to evaluate air leakage rates within the Solar-MEC system and actions to minimize such leakage are reported. The test design and experimental approach to verify the performance of the rotary regenerative (sensible) heat exchanger are reported.

56274 (COO—4643-T2) **Continuing regional solar energy information mini-center activities and updating the SOLCOST program. Quarterly report.** Lantz, L.J. (Solar Environmental Engineering Co., Inc., Fort Collins, CO (USA)). Jul 1979. Contract EG-77-C-02-4643. 71p. Dep. NTIS, PC A04/MF A01.

Progress in the various tasks in the program to develop SOLCOST is reviewed. SOLCOST examples are included in appendices. (MHR)

56275 (COO—5045-T1) **Plans and specifications for: the installation of a solar heating system on the Grayview Building, Two Lakeview Avenue, Lynbrook, New York.** (Carman-Dunne, Inc., Lynbrook, NY (USA)). 10 Jun 1979. Contract ET-78-F-02-5045. 59p. Dep. NTIS, PC A04/MF A01.

Plans and specifications are presented for the installation and initial operation and adjustment of a closed loop, solar powered space heating and hot water heating system with roof mounted liquid collectors. (MHR)

56276 (DOE/CS/4281—1) **Model document for code officials on solar heating and cooling of buildings. Second draft.** (Department of Energy, Washington, DC (USA). Office of Solar Applications and Commercialization). Sep 1979. 121p. Dep. NTIS, PC A06/MF A01.

Guidelines and codes for the construction, alteration, moving, demolition, repair and use of solar energy systems and parts thereof used for space heating and cooling, for water heating and for processing purposes in, on, or adjacent to buildings and appurtenant structures are presented. The necessary references are included wherever these provisions affect or are affected by the requirments of nationally recognized standards or model codes. The purpose of this document is to safeguard life and limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, location and maintenance of solar energy systems in, on, or adjacent to buildings and appurtenant structures.

56277 (ISM—213) **Experimental approach for studying direct solar gain optics of model interiors.** McClelland, J.F.; Fuchs, R.; Kniseley, R.N. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 6p. (CONF-790541—56). Dep. NTIS, PC A02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

An experimental approach is discussed for measuring the effective solar absorptivity and related optical properties of direct gain interiors. Measurements can be made on a zone or total interior basis using easily constructed models. The study covers characterization requirements, experimental methods, measurement theory, and preliminary experimental results. The data that can be acquired through this approach will be of use in the economical integration of direct gain solar collection with a wide variety of building interiors.

56278 (ISM—231) **Potential for passive retrofit in Iowa.** Hull, J.R.; Hodges, L.; Block, D.A. (Iowa State Univ. of Science and Technology, Ames (USA)). 1979. Contract W-7405-ENG-82. 5p. (CONF-791022—5). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

Analysis of data from a survey conducted in several Iowa cities and towns indicate that passive solar retrofit techniques can supply a significant percentage of the residential heating requirements for the state of Iowa. Heat loss coefficients and direct gain passive contributions are generated under scenarios of moderate and strong conservation. The amount of auxiliary heat needed after retrofit is compared to that needed before retrofit for the case of no storage and 1-day storage. As a conservative estimate, passive retrofit techniques can reduce the auxiliary heating requirements by an average of 20%.

56279 (ISM—232) **Use of concrete cored slab for passive cooling in an Iowa residence.** Block, D.A.; Hodges, L. (Iowa State Univ. of Science and Technology, Ames (USA)). 1979. Contract W-7405-ENG-82. 4p. (CONF-791022—7). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

A concrete cored slab with a mass of about 40 metric tons (44 short tons) will serve as an important passive component in the Hodges Residence in central Iowa. This slab is 25 cm (10 in) thick, with one 15-cm (6-in) diameter core every 20 cm (8 in). The slab will be cooled down at night, when the temperature rarely fails to drop below 20°C (68°F), by drawing outside air through the cores with a small furnace fan. The slab will be held in reserve during the day until the late afternoon, when indoor air can be cooled by circulation through the slab. Other passive cooling contributions of the home arise from earth-contact cooling, natural ventilation, and forced ventilation.

56280 (LA-UR—79-2495) **Solar economic analysis: an alternative approach.** Thayer, M.A.; Brunton, D.; Noll, S.A. (New Mexico Univ., Albuquerque (USA); Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 3p. (CONF-791022—4). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

Conventional economic analysis which utilizes the discounted present value criterion is examined from a critical perspective. It is found that this technique has a number of limiting characteristics which contribute to the lack of general usage of economic analysis for evaluating passive solar installations. Within this context an alternative approach is suggested for determining the economic desirability of such investments. This latter method, compound future worth analysis, is found to be both more understandable and flexible.

56281 (SOLAR/1005—78/14) **Solar Energy System Performance Evaluation: May-August 1978. Florida Gas Company, Single Family Residence, Winter Springs, Florida.** Lee, T.D.; McCumber, W.H.; Murphy, L.J. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract EG-77-C-01-4049. 39p. Dep. NTIS, PC A03/MF A01.

A brief description of the system, which provides thermal energy for space heating, space cooling and domestic hot water heating for a one story single family dwelling, is given. A performance evaluation of the cooling subsystem is presented for the period May through August, 1978. A comparison of measured climatic data with long term average conditions for the vicinity is made. Subsystem performance, including collector array, storage, and space cooling systems, is discussed and design modifications that would improve the system's overall economic performance are considered. Space cooling is provided by an Arkla Model WF-35, 3-ton absorption cycle chiller. A comparison of the present system configuration with a vapor compression air conditioner is presented showing that net savings are realized when the present system is operated solely with solar supplied energy.

56282 (SOLAR/1034—78/14) **Solar Energy System Performance Evaluation: March-August 1978. Alpha Construction Company, Single Family Residence, Canton, Ohio.** McCumber, W.H.; Murphy, L.J. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract EG-77-C-01-4049. 53p. Dep. NTIS, PC A04/MF A01.

An operational summary of the solar energy system installed at the Alpha Construction Company Single Family Residence in Canton, Ohio is presented. The system and its four modes of operation including space heating, storage and domestic water preheat, are described. The system performance is assessed and analyzed with respect to meteorological load and operational conditions. Subsystems performance is also presented. Measured monthly values for subsystem operating energy are tabulated. The subsystem availability is defined and noted to be 100 percent during the report period. The monthly energy savings are tabulated.

56283 (TID—29008) **Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.** (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 20 Aug 1978. Contract EY-76-S-02-2588. 220p. Dep. NTIS, PC A10/MF A01.

The status of TRNSYS, as it has been made available to outside users and how service to program holders has been provided, is summarized briefly. System and component studies which are part of the process of evolution of TRNSYS are dealt with. Design methods, including f-chart and its use and follow-on design methods are discussed. Progress is described on comparison of numerical experiments and physical experiments. Papers prepared under the contract are included in appendices. Separate abstracts are prepared for 10 of them. (MHR)

56284 (TID—29008, pp 64-68) **Heat pumps: do they make economic and performance sense with solar.** Mitchell, J.W.; Freeman, T.L.; Beckman, W.A. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

It is concluded that ocst-effectiveness for conventional solar systems and conventional heat pump systems separately does not ensure the cost-effectiveness of a combined solar and heat pump system. The costs of solar and heat pump systems, individually, are quite high, and the cost of a combined system reflects both of these costs. Based on heating season performance alone, the parallel system appears to be the best combined system, but the economical choice may still be a conventional heat pump or a conventional solar system.

56285 (TID—29008, pp 69-96) **Transfer functions for combined walls and pitched roofs.** Pawelski, M.J. (Trane Co., LaCrosse, WI); Mitchell, J.W.; Beckman, W.A. 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

An alternative technique for determining the transfer function coefficients for the equation for heat flux through any wall or roof to a room at constant temperatures is presented. A transient response for the wall or roof to given set of forcing temperatures is first computed using a finite difference representation, although any method could be used including actual experimental measurements. A linear least squares regression technique is then employed on the coefficients to determine the best fit to the response. A procedure for selecting the minimum number of coefficients needed for a given wall is presented. The results of the technique are compared to known coefficients to verify the method. The approach is then extended to walls and flat roofs with parallel resistances. A procedure for combining several walls of similar construction but different orientation is developed. Finally, a transfer function model of a roof-attic-ceiling combination is developed.

56286 (TID—29008, pp 115-121) **Simulations of the performance of open cycle solar-desiccant systems.** Mitchell, J.W.; Beckman, W.A.; Nelson, J.S. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

A feasibilty study of open cycle air conditioning systems that use solid desiccants and solar energy has been conducted. Seasonal simulations were performed for the Miami, FL, climate for two system configurations. These are the ventilation mode, in which ambient air is continually conditioned and introduced into the room space, and the recirculation mode, in which room air is reconditioned and recirculated. The significant ideas involved in the design, control, and operation of the system are discussed. The importance of a high effectiveness sensible heat exchanger is noted. Control systems which sense both temperature and humidity in the conditioned space are required, with the controlled variables being the temperature at which the desiccant is regenerated and the effectiveness of the evaporative coolers. The strategy necessary to minimize energy consumption and the influence of climate on the selection of a particular configuration are considered. These studies are for one of a large number of possible system configurations, using one of several types of heat and mass transfer components, one control strategy and for one climate. No general conclusions can be drawn regarding the feasibility of desiccant cooling systems, but the results presented are encouraging and further explorations are warranted.

56287 (TID—29008, pp 130-132) **FCHART version 3.0: current status of the University of Wisconsin computer program for solar heating design.** Hughes, P.J. (Science Applications Inc., McLean, VA). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

The f-chart design method has been developed to size components of solar heating systems shown. The effect of collector type and collector, storage, and heat exchanger sizes on system performance can be determined using the f-chart approach. When compared to simulation, f-chart retains all of the necessary design flexibility for the four systems shown, plus the method is simple enough for hand calculations. The FORTRAN computer program FCHART was

written as a convenient tool for solar designers. Although it re-established the need for a computer, computers are already in common use by architects and HVAC engineers. Version 3.0 represents the current status of the evolving f-chart approach. Improvements since earlier versions of the program and the assumptions implicit in the use of FCHART are described.

56288 (TID—29008, pp 157-180) **Economic evaluation and optimization of solar heating systems.** Brandemuehl, M.J.; Beckman, W.A. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

Life cycle cost analysis is used to evaluate economic comparisons between residential solar heating systems and conventional heating systems. The comparison is expressed as the life cycle savings of the solar system over the conventional system. A procedure which simplifies the life cycle cost comparison is developed by introducing two economic parameters, P_1 and P_2. These parameters relate all life cycle considerations to the first year fuel savings or the initial solar system investment cost. They can accommodate arbitrary time variation of annual costs and discounting of future costs to present dollar values, while expressing the life cycle savings equation in a compact form. Assuming a linear relationship between the solar system investment cost and the collector area, the simplified savings equation is optimized with respect to collector area. Straightforward manipulation shows that the optimum condition is defined by one economic parameter for a given location and collector type. Using the f-chart design method, tables are generated which give the optimum collector area to annual load ratio, and the optimum load fraction supplied by solar energy, as a function of this economic parameter. This non-iterative optimization procedure is applied to a standard domestic water heating system, a combined space and domestic water heating system with air as the transfer-medium, and a combined system with liquid as the transfer-medium.

56289 (TID—29008, pp 184-200) **Comparisons of measured and simulated performance for CSU House I.** Mitchell, J.W. (Univ. of Wisconsin, Madison); Beckman, W.A.; Pawelski, M.J. 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

The heating system for CSU House I is simulated using TRNSYS, and simulation results are compared to the measured performance. The heating system is composed of a liquid collection and storage system, a domestic hot water system, and an air delivery system. The components were modeled using standard TRNSYS components. Measured weather data from the site were employed as the driving function. Measured energy quantities, including the useful gain from solar, that supplied to the house and the domestic hot water system, and the auxiliary were compared to those from the simulation for three periods of six to eleven days each. Comparisons were made on both a daily basis and over the entire period. The simulated energy quantities are found to agree with the data within the accuracy of the measurements. Simulated hourly values of storage tank temperatures are compared to those measured. Although there are differences of up to 5C between the two at times, the agreement is generally within 2C. These results help establish the validity of simulation methods for system analysis. Conventional engineering techniques can be used to formulate component models and determine parameter values. Verified simulation models can be then used to predict long term system performance.

56290 (TID—29008, pp 201-204) **Comparison of four solar system simulation programs in solving a solar heating problem.** Freeman, T.L. (Univ. of Wisconsin, Madison); Maybaum, M.W.; Chandra, S. 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

Two problems, liquid and air solar heating, were defined and solved by CAL-ERDA, HISPER, LASL and TRNSYS. The results are discussed briefly. (MHR)

56291 (TID—29008, pp 205-218) **Computers in the design of solar energy systems.** Klein, S.A.; Mitchell, J.W.; Duffie, J.A.; Beckman, W.A. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

Simulations are tools of major importance in the design of solar energy systems. Only with simulations can a variety of system designs be studied and evaluated in a comparative way. Simulations are used both for systems research and as a design tool for large, one-of-a-kind systems, using programs such as TRNSYS. Simulations are also the basis for development of quick design methods for standard system configurations for solar heating; these quick methods are also programmed for easy use in combination with economic analyses (e.g., f-chart).

56292 (TREE—1384) **Commercial prototype design of a solar heating/cooling system for a manufactured home.** Scofield, M.P.; Lau, A.S.; Liebelt, K.H.; Shinn, N.R.; Schafer, T.L. (Idaho National Engineering Lab., Idaho Falls (USA); Boise Cascade Corp., ID (USA)). Sep 1979. Contract EY-76-C-07-1570. 125p. Dep. NTIS, PC A06/MF A01.

A prototype design is presented for a solar heating and cooling system for a manufactured modular home. The objective was to develop an active solar system for space heating that would be competitive with conventional energy sources; that is, the increase in the mortgage payment would be completely and simultaneously recovered from energy savings. The heating and cooling system features air collectors that are structurally part of the south facing rear wall, rock storage that is in the basement, and a heat exchanger that preheats domestic hot water. Summer cooling is achieved by cooling rock storage at night and circulating house air through the storage during the day as required. Two nearly identical homes were designed and built incorporating the prototype system. Both in Idaho, one house is located in Boise, the other in Idaho Falls, placing the homes in distinctly different climates. Both homes are being monitored for a two-year period to obtain dynamic and long-term performance data. The results of the monitoring will be the subjects of further reports.

56293 **Collection, processing, and dissemination of data for the National Solar Demonstration Program.** Day, R.E.; Murphy, L.J.; Smok, J.T. (IBM Corp., Huntsville, AL). pp 75-83 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; University of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The National Solar Heating and Cooling Demonstration Program encompasses a variety of solar installations, in different kinds of buildings under varying climatic conditions. The International Business Machines Corporation (IBM), under the auspices of both the National Aeronautics and Space Administration (NASA) and the Department of Energy (DOE), is participating in this effort. The DOE solar sites are composed of Housing and Urban Development (HUD) residential sites, Program Opportunity Notice (PON) commercial sites and other DOE sites (i.e., Department of Defense (DOD), etc.). The NASA effort encompasses the Operational Test Sites (OTS). The Demonstration Program has as a major goal the collection and analysis of data to determine solar energy system performance. In order to collect, organize, control, and analyze the data available in this program, a National Solar Data System has been developed for the Department of Energy, by the International Business Machines Corporation in Huntsville. This system provides for an automatic gathering, conversion, transfer, and analysis of demonstration site data. IBM Huntsville's role in the Demonstration Program is discussed.

56294 **Design and performance of solar heating and hot water systems using pyramidal optics low gain concentrating systems.** Wormser, E.M. (Wormser Scientific Corp., Stamford, CT). pp 109-128 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; University of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The design and performance of a 1400 sq ft ranch house located near Rehoboth, Delaware, which utilizes a 370 sq ft entrance aperture Pyramidal Optics Concentrating type solar system with a dual source heat pump auxiliary unit are discussed. The performance of the system from October to December, 1976, is described. Total cost of auxiliary electrical energy for heating for three severe winter months was $35.53. The same type of concentrating optical solar collection system has been applied to two four-townhouse condominium buildings, part of the 400-unit Yacht Cove development, located near Columbia, South Carolina. This system uses solar collectors on only two out of four buildings and a central storage which makes the system highly cost effective. Both four townhouse condominium units are presently in operation. The second unit has been completely instrumented using a DOE/IBM SDAS system. It is expected that performance data on this unit will be available shortly.

56295 **Solar-powered Rankine heat pump for heating and cooling.** Rousseau, J. (AiResearch Manufacturing Co. of California, Torrance). pp 253-267 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

In the heating mode of operation, a vapor-cycle heat pump using R-11 as the working fluid processes solar thermal energy collected at low temperature (40° to 80°F) to a temperature level suitable for space heating. The heat pump features a motor-driven centrifugal compressor. By controlling the speed of the compressor so that the heat pump capacity matches the heat load, seasonal COP's on the order of 8 can be achieved. In the cooling mode of operation, the solar thermal energy is used in a Rankine power loop to drive the heat pump compressor. Valves are incorporated in the

system for reversing the vapor compression loop from the heating to the cooling mode of operation. The thermal COP (cooling load/solar heat input) is estimated at about 0.7. The operating range of the machine in terms of the solar heat source temperature is from 155° to 220°F. The system features a turbine, a compressor, and a permanent magnet motor mounted on the same shaft, thus eliminating the requirements for gears. Further, the rotor is supported on process fluid bearings. The machine is completely hermetic, and no lubricants other than the process fluid are required. This hermetic turbocompressor/motor is powered in the electrical mode by high-frequency power generated in a solid-state converter from utility power. By controlling the frequency of the current from the converter to the motor, variable speed operation is achieved. Operation and performance of the system is described.

56296 HYCSOS solar energy driven heat pump. Sheft, I.; Gruen, D.; Lamich, G. (Argonne National Lab., IL). pp 299-308 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The Argonne HYCSOS system is a solar energy driven chemical heat pump using metal hydrides that functions in heating, cooling, and energy conversion modes. When used with a solar energy collector as the thermal input, a hydride, e.g., $CaNi_5$, is decomposed and the released hydrogen is absorbed at a lower, intermediate, temperature, and stored as a second hydride, e.g., $LaNi_5H_6$. The heat pump mode is the low temperature dissociation of the $LaNi_5H_6$ and the absorption of the hydrogen at the intermediate temperature. The intermediate temperature is available for space heating, using solar energy during periods of insolation and using low temperature ambient heat via heat pump action during other times. Operated in a reverse mode, the system can be used for direct refrigeration, eliminating the conversion of solar thermal energy to mechanical energy as is done in the operation of a conventional air conditioner. With three tanks of the same hydride cycling between a high temperature and a lower one, a continuous supply of high pressure hydrogen can be generated, do useful work, in an expansion engine-dynamo unit supplying electricity, and then be absorbed on the alloy at the lower temperature. A demonstration test facility has been constructed to evaluate experimentally the HYCSOS chemical heat pump and energy conversion concept. The unit is of sufficient size that thermal losses are small compared to measured heat transfer rates in a heat storage mode, refrigeration mode, and power generation mode.

56297 Heat pump in relation to solar energy. Keable, J. (HELIX Multi Professional Services, London, England). pp 43-48 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The components of a heat-pumping system are briefly reviewed. Electricity and alternate power sources including, gas, oil, wind-power methane and alcohol are discussed as feasible power sources for heat pumps. It is noted that heat pumping is suitable in the majority of energy use categories, including space-heating food preservation by cooling, hot water heating as well as many industrial applications. Cost in use (capital cost of a system divided by an assumed installation life span) is used as a figure of merit to compare a conventional hot air heating system with a solar system and an electrically driven heat pump. No adverse environmental side effects are foreseen if heat pumps are produced in large quantities.

56298 Economic considerations in the energy supply of Autarkic dwellings. Littler, J.G.F.; Thomas, R.B. (Univ. of Cambridge, England). pp 64-77 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

Data from computer simulations run in conjunction with live weather data are presented showing energy requirements for the Autarkic house. Meeting the energy requirements by either a solar heating system or a wind generator system using resistance heating is considered. A computer simulation is used to vary the elements of these two systems. A comparison of varying volumes of storage medium and insulation is presented for the solar heating system. A table of losses associated with supplying electricity from windmills is given. The trade-off between mill size and storage volume and the costs of a windmill system are discussed.

56299 (ORO—4942-T1) Completion of repairs to the Shenandoah (Georgia) Community Center Solar Heating, Cooling, and Hot Water System. Final report. Jeter, S.M. (Georgia Inst. of Tech., Atlanta (USA). Coll. of Engineering). [nd]. Contract EY-76-S-05-4942. 34p. Dep. NTIS, PC A03/MF A01.

The development, implementation, and operation of an enhanced freeze-protection system for the Shenandoah Solar Community Center in Shenandoah, Georgia, is described. Freeze damage incurred primarily during the winter of 1977 to 1978 was repaired which entailed closing scores of leaks in absorber tubes, collector headers, module headers, and supply piping along with the replacement of most of the exterior pipe insulation. To prevent further damage, an isolation heat exchanger has been installed to allow the array to be filled with a water/glycol solution during cold weather periods. Operational and maintenance manuals for the system were prepared and training provided to the operator.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 56276

56300 Process drying of soybeans using solar energy. Guinn, G.R. (Teledyne Brown Engineering, Huntsville, AL). pp 333-342 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The design of a solar energy system for the process drying of soybeans is reviewed and problems that arose in the construction and the checkout phase are described. A detailed description is provided of a high pressure washdown system for removing surface contamination. Life cycle costs are determined for two design alternatives.

56301 Solar production of industrial process hot water using shallow solar ponds. Guinn, G.R.; Hall, B.R.; Wallace, D.B. (Teledyne Brown Engineering, Huntsville, AL). pp 355-383 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The final design of a system of Shallow Solar Ponds (SSPs) to provide moderate-temperature water for a poultry canning operation located in Athens, Alabama, is summarized. The project is funded under the Department of Energy's Solar Demonstration Program for Agricultural and Industrial Process Heat. Design of the shallow pond collector is based on concepts developed at Lawrence Livermore Laboratory under previous programs. The 16,740 ft^2 of ponds are designed to conserve 3.7×10^9 Btu per year of fossil fuel by heating 40,000 gal of water daily in plastic bags contained within concrete curbing and glazed with reinforced fiberglass plastic. A heat exchanger isolates the solar loop from the plant loop. Based on contractor bids for installation cost and reasonable values of financial and tax parameters, the system would not be economically attractive in a commercial environment. It is concluded that bag materials and designs approved for potable use must be developed before SSPs can become cost-effective for application to food processing.

WATER HEATING

REFER ALSO TO CITATION(S) 56206, 56272, 56275, 56276, 56282, 56294

56302 (SOLAR/1017—78/14) Solar Energy System Performance Evaluation: March-August, 1978. Facilities Development Corporation, Condominium, San Diego, California. (International Business Machines Corp., Huntsville, AL (USA)). 1978. Contract EG-77-C-01-4049. 45p. Dep. NTIS, PC A03/MF A01.

An operational summary of the solar energy system installed at the Facilities Development Condominium complex in San Diego, CA is presented. A system description is provided. Performance evaluation techniques are described and the actual system performance during the report period is reviewed. Performance of major subsystems is presented. An analysis of performance based on evaluation of climatic load and operational conditions is given. Monthly values of average daily insolation and average ambient temperature measured at the site, as well as the long term average monthly values for these climatic parameters, are tabulated.

56303 Solar water heating: some economic and commercial aspects. McNelis, B. (General Technology Systems Ltd., Hounslow, England). pp 54-63 of Economic and commercial assessment of solar energy conversion. London, England; International Solar Energy Society (1977).

From Conference on economic and commercial assessment of solar energy conversion; London, UK (Jul 1977).

The current state of solar water heating in the United Kingdom is reviewed, and the cost effectiveness of solar water heating systems is discussed. Manufacturer's data on energy delivered from flat plate collectors system is tabulated. Savings to be realized for different collector areas and efficiencies are summarized. Annual costs of a solar system supplementing an electric water heating system for different efficiencies are graphed. The payback period for a solar installation is graphed against the cumulative savings achieved.

OTHER

56304 **Bicameral solar water lift.** Taganov, K.; Pushkarev, V.Ya. pp 104-106 of Isol'zovanie solnechnoi energii v narodnom khozyaistve SSSR. Blum, V.A. (ed.). Moscow, USSR; Izdatel'stvo Nauka (1965). (In Russian)

A description is given of the design and operation of a bicameral solar waterlift for use in the Soviet Union's desert regions for pumping underground potable water. A diagram is presented illustrating the equipment and its mode of operation. The production costs of lifting a cubic meter of water, discounting the wages of service personnel, are shown to be approximately 2 to 3 kopecks.

SOLAR COLLECTORS AND CONCENTRATORS

56305 (ALO—4136-T1) **Experimental and theoretical study of thermal performance of a hybrid solar system at Living History Farms. Technical progress report No. 5, 16 Feb 1979-15 Jun 1979.** Hull, J.R. (Ames Design Collaborative, IA (USA)). 1979. Contract EG-77-G-04-4136. 12p. Dep. NTIS, PC A02/MF A01.

The construction of the solar pond was completed, the pond was filled with high concentration salt water, a salt gradient was established in the upper part of the pond, and the pond has begun to collect and store heat. Work in the immediate future will include improving the transparency of the pond and beginning construction on the main section of the passive solar house.

56306 (DOE/EIA—0174(78)) **Energy data report. Solar collector manufacturing activity, July 1978 through December 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Sep 1979. 47p. Dep. NTIS, PC A03/MF A01.

The number of companies engaged in the sale of thermal collectors dropped from 297 to an estimated 254, a 14% decrease. Producer shipments by the manufacturers declined from 6.28 million to 4.58 million square feet during the latter half of the year. (MHR)

56307 (DOE/NASA/CR—161306) **Indoor test for thermal performance of the Sunmaster evacuated tube (liquid) solar collector.** (Wyle Labs., Huntsville, AL (USA). Solar Energy Systems Div.). Sep 1979. Contract EM-78-C-01-5180; EX-76-A-29-1037. 41p. Dep. NTIS, PC A03/MF A01.

The test procedure used and the results obtained from an evaluation test program conducted to obtain thermal performance data on Sunmaster DEC-8 and 8A (modified) solar collector under simulated conditions are described. These tests were made using the Marshall Space Flight Center's solar simulator. A time constant test and incident angle modifier test were also conducted to determine the transient effect and the incident angle effect on the collector. The Sunmaster evacuated tube solar collector is a water working fluid type. The gross collector area is about 17.17 ft^2 and weight is approximately 65 pounds empty and 90 pounds filled. The overall dimensions are about 48" x 51.5" x 7.8".

56308 (ISM—233) **Preliminary experimental results on the optical properties of model direct solar gain interiors.** McClelland, J.F.; Fuchs, R.; Kniseley, R.N.; Block, D.A.; Hodges, L. (Ames Lab., IA (USA); Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). 1979. Contract W-7405-ENG-82. 5p. (CONF-791022—3). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

An assessment is presented of conditions necessary for quantitative characterizations of direct solar gain optical properties using photoacoustic measurements. Means of satisfying the experimental requirements are discussed in detail.

56309 (Juel-Spez—37) **Optimization of reflector-boosters for solar flat-collectors.** Profant, M.; Weidner, P.; Boettcher, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralinstitut fuer Angewandte Mathematik). Apr 1979. 61p. Dep. NTIS (US Sales Only), PC A04/MF A01.

To increase the working temperature of solar energy systems two-sided collectors together with appropriate reflectors are used. Here, the efficiency of various reflector shapes was investigated and attempts made to optimize them under several criteria. The results indicate that with cheap and simple to manufacture reflectors good energy gains can be expected.

56310 (LBL—9697) **Experimental test facility for selective radiative cooling surfaces.** Sakkal, F.; Martin, M.; Berdahl, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 7p. (CONF-791022—92). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

The newly constructed radiator test facility at Lawrence Berkeley Laboratory is described and preliminary results are presented for cooling rates from two radiating surfaces.

56311 (MDC-G—7543) **Dust buildup tests of heliostats and mirror specimens.** Blackmon, J.B. (McDonnell Douglas Astronautics Co., Huntington Beach, CA (USA)). Sep 1978. Contract EY-76-C-03-1108. 86p. Dep. NTIS, PC A05/MF A01.

Reflectivity variation data are presented for full-scale heliostats and sixty mirror specimens that were tested in a desert environment. Factors investigated included weather, site location, mirror type, and storage position. A method of obtaining reflectivity data for heliostats and specimens under field conditions is presented. Reflectivity degradation rates are determined for different storage positions and compared with weather conditions. Time-averaged reflectivity values are determined. Natural cleaning effectiveness of rain, snow, and frost is discussed. Heliostat operational procedures which appear to decrease reflectivity losses due to dust buildup are described.

56312 (SAND—79-0726C) **Utilization of heavy fill gases in annular solar receiver geometries for heat loss reduction.** Ratzel, A.C. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 31p. (CONF-791205—6). Dep. NTIS, PC A03/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

Analytical and experimental work has investigated reducing thermal conduction and natural convection heat losses in annular solar receiver geometries using high molecular weight fill gases. Gases analyzed in a Sandia Laboratories prototype receiver design included nitrogen, argon, krypton, xenon, sulfur hexafluoride, and Freon C-318. Experimental results indicate that high molecular weight monatomic gases can reduce receiver heat loss by nearly 50%, comparable to annulus gas evacuation to the 5.0 to 5.0 x 10^{-1} Pa range. Computer simulation studies show that heavy gas utilization in the annular space can improve overall collector performance by 4.5 to 13.5%, depending upon the gas and annulus pressure.

56313 (SAND—79-1754C) **Preparation of thin films for solar energy utilization.** Mattox, D.M. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 17p. (CONF-791013—2). Dep. NTIS, PC A02/MF A01.

From 26. national vacuum symposium; New York, NY, USA (2 Oct 1979).

Thin film deposition techniques have made and are making a significant contribution to solar energy utilization. Commercial applications of thin films include photothermal selective absorbers formed by electroplating, chemical conversion and vacuum processing; solar reflectors formed by vacuum processes; heat reflectors formed by vacuum processes and spray pyrolysis; antireflection coatings formed by vacuum processes and chemical leaching and the metallization of photovoltaic cells. CdS/Cu_2S photovoltaics formed by vacuum processes and spray pyrolysis are also close to commercial utilization. Principle concerns in thin films applications include economics of fabrication and environmental stability of the thin film materials. At the present time, for many applications the best and most economical film deposition technology is not yet defined. One of the major problems with thin film evaluation is the lack of acceptable testing procedures particularly as related to lifetime. Research and development is continuing in the application of sophisticated thin films to photovoltaic conversion and other applications. The status of thin films in solar energy utilization is reviewed.

56314 (STU—78-4234) **Aging and corrosion problems of plane thermal solar collectors: literature and field investigations.** Wennerholm, H.; Lagerkvist, K.U. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). 1979. 73p. (In Swedish). (SP-RAPP—1979-4). Dep. NTIS (US Sales Only), PC A04/MF A01.

The literature and field investigation will be the basis of a project concerning the development of standardized methods for the test of solar collectors which are used in heating and cooling systems. The literature and field investigations include the study of the construction of plane thermal solar collectors as well as atmospheric degradation processes on different construction materials.

56315 (STU—78-5203) **Importance of efficient and resistant selective layers in solar collectors.** Andersson, A.; Sundberg, R.; Westerstrand, B. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Dec 1978. 11p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The importance of selective layers for the efficiency of solar collectors has been investigated. The results show that the surface area of the collector could be decreased 15% when using a selective area. The costs for the layers will be of the same order as those for painting the area. Thus the efficiency of the absorber can be increased drastically without increasing the costs. The following three conditions must be fulfilled to make selective layers competitive in the future: (1) the layers must have good selective qualities, (2) they must be cheap and suitable for industrial production, (3) they must be corrosion resistant.

56316 (TID—29008, pp 147-156) **Calculation of flat-plate collector utilizability.** Klein, S.A. (Univ. of Wisconsin, Madison). 20 Aug 1978.

In Simulation and design of solar thermal processes. Progress report, February 1977-August 1978.

The utilizability or phi-curve method developed by Whillier and later generalized by Liu and Jordan, can be a very useful design tool for some types of solar energy systems which utilize conventional flat-plate solar collectors. The generalized phi-curve method in its original form, however, has several drawbacks. The calculation effort required to assess long-term collector performance is significant. The calculations can not be completely automated on a computer or hand calculator because many graphs are needed for which analytical representations are not available. In this paper, the phi-curve method is reviewed and situations for which the method is useful are described. Then, an easier method, using daily anti phi-charts, rather than the original hourly phi-curves, is presented. The anti phi-charts greatly reduce the calculations required to determine flat-plate collector utilizability. Anti phi-charts can be easily implemented on a programmable hand calculator. A comparison of the original hourly and the new daily calculation methods is presented. An example demonstrating the use and utility of the anti phi-charts is also included.

56317 **Orientation and tilt angle of a solar collector.** Reisz, A.I. (Reisz Engineering Co., Huntsville, AL). pp 419-425 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

The southward orientation and the optimum tilt angle for the latitude of site location are basic design considerations. Often, when considering the use and surrounding conditions that the solar collector will be subjected to, these basic design rules must be adjusted. Whether the system will be used for heating the year around, heating seasonally, or both heating and cooling will affect the optimum tilt angle. Collector structure cost also affects this angle. Aesthetical considerations and the surrounding area usage and shadows may adjust the collector orientation. The relationship of the amount of intercepted solar energy to both collector tilt angle and orientation is nonlinear. Small shifts from theoretical optimum have negligible losses in collected energy. The loss in collected energy due to collector shift from theoretical optimum must be evaluated with the system economics and usage. Knowledge of this relationship enables the designer to make decisions in the best interest of the solar energy system user.

HEAT STORAGE

56318 (CONF-781142—, pp 193-198) **Development of a practical photochemical energy storage system.** Kutal, C.; Hautala, R.R.; King, R.B. (Univ. of Georgia, Athens). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A photochemical energy storage system based on the interconversion of norbornadiene and quadricyclene is discussed. Significant progress has been made in the development of suitable sensitizers (organic and inorganic) for the energy storage step and catalysts for the energy release step.

56319 (CONF-781142—, pp 315-321) **Hydrocarbon entrapment of light energy of the sun (HELEOS): a complementary method to thermal energy storage for building heating.** Rose, T.L.; Mariano, P.S.; Fisher, L.; Leone, A.A. (Texas A and M Univ., College Station). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

Storage of solar energy via photochemical reactions is analyzed as an alternative method of low temperature energy storage. The analysis shows that while on a technical basis the method holds promise, a great deal of research and development is necessary, particularly in the area of photosensitization before its utilization in a practical system can be considered.

56320 (COO—4480-T1) **Hybrid thermal storage with water. Semiannual progress report, September 1, 1977-May 15, 1978.** Moriarty, M.P. (Rockwell International Corp., Canoga Park, CA (USA)). May 1978. Contract EG-77-C-02-4480. 112p. Dep. NTIS, PC A06/MF A01.

Four distinct hybrid thermal storage concepts have been defined. These include the use of a water tank in a rock bed, the use of a tank buried in the earth, the use of a heavily insulated tank and the use of a below grade level tank with surrounding air space. Using these concepts, five preliminary designs have evolved that appear to warrant further analysis. TAP VI, a highly flexible, generalized conduction heat transfer analysis code has been modified to be used as a subroutine in systems analysis codes. The modifications include the capability of using multiple fluid streams, making it particularly suitable for the analysis of hydrid storage systems.

56321 (SAND—79-1803C) **Comparative analyses of solar energy storage cycles.** Hackett, C.E. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 25p. (CONF-790954—1). Dep. NTIS, PC A02/MF A01.

From 18. international conference on solar energy; Milan, Italy (23 Sep 1979).

A thermodynamic technique is presented which will enable the assessment of the overall performance of various storage options on an absolute basis so that cost effective designs can be developed to obtain the full thermodynamic and system advantages of energy storage. First the underlying thermodynamic principles of entropy production analysis are examined. The various energy storage schemes are classified. Detailed analyses were developed to cover the various generic types of energy storage which are appropriate for solar power systems. (MHR)

56322 **Computer simulation of a solar energy system with a viscous-entrainment liquid storage tank model.** Han, S.M.; Wu, S.T. (Univ. of Alabama, Huntsville). pp 165-183 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; University of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

Existing models for the liquid solar energy storage system do not properly consider viscous entrainment effects of jet streams which cause turbulent mixing inside liquid storage tanks. Turbulent mixing reduces thermal stratification adjacent to jet streams and prevents jet streams from going further down to the bottom of the storage tank. To account for viscous entrainment effects, a set of partial differential equations is derived and an implicit finite difference method is employed for its solution. TRNSYS solar energy simulation with this viscous-entrainment liquid storage model is carried out for a hot water application. Simulation results show that the viscous entrainment model represents more realistic storage tank performance compared with other existing models.

56323 **Three dimensional mathematical model of flow stratification in thermocline storage tanks.** Sha, W.T.; Lin, E.I.H. (Argonne National Lab., IL). pp 185-202 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. Huntsville, AL; Univ. of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

A three-dimensional, transient, single-fluid, single-phase mathematical model, the COMMIX-SA computer program, is being developed to investigate the flow stratification phenomena that occur in thermocline storage tanks, and the effects of stratification on solar systems performance. The model solves the conservation equations of mass, momentum, and energy as an initial value problem in time and a boundary value problem in space. Details on the formulation of the model and the numerical techniques employed are described, and special features of the model are discussed. The model has been used to analyze several storage-tank stratification problems. The results indicate that the model is capable of predicting realistically the flow and temperature distributions in storage tanks. The predictions are in good qualitative agreement with experiments and show substantial improvement over those obtained by the TRNSYS one-dimensional model. Three-dimensional effects are evident, and some parametric studies are suggested.

GEOTHERMAL ENERGY

56324 **Commercialization of geothermal resources.** Davis, CA; Geothermal Resources Council (1978). 80p. (CONF-781183—).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Twenty-two papers are included. Separate abstracts were prepared for twenty-one. One is listed by title. (MHR)

RESOURCE STATUS AND ASSESSMENT

56325 **Overview of worldwide geothermal developments.** Meidav, T. pp 7-10 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Geothermal development in the US, Japan, the Philippines, Indonesia, Mexico, Central America, South America, and other countries is reviewed briefly. (MHR)

USA

56326 (COO—4362-4) **Low-temperature geothermal reservoir site evaluation in Arizona. Quarterly progress report, February 1—April 30, 1978.** Hahman, W.R. Sr. (Arizona Univ., Tucson (USA). Bureau of Geology and Mineral Technology). Jul 1978. Contract EG-77-S-02-4362. 128p. Dep. NTIS, PC A07/MF A01.

Separate abstracts were prepared for six of the seven papers included here. The other one is listed by title. (MHR)

56327 (COO—4362-4, pp 113-120) **Ranking of geothermal resources in Arizona.** Swanberg, C.A. Jul 1978.

In Low-temperature geothermal reservoir site evaluation in Arizona. Quarterly progress report, February 1—April 30, 1978.

The resources have been divided into high temperature (> 150°C), intermediate temperature (90 to 150°C) and low temperature (20 to 90°C) with further modifications to determine the reliability of the assessment. These resources are categorized as confirmed, prospects or potential for discovery. (MHR)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

56328 **Nature, occurrence, and utilization of geothermal energy.** Wright, P.M. (Univ. of Utah.Research Inst., Salt Lake City). pp 1-6 of Commercialization of geothermal resources. Davis, California; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

The geothermal resource types are listed. The mechanisms of hydrothermal resources are sketched. Resource distribution, energy conversion systems, and production and heat extraction technologies are reviewed briefly. (MHR)

USA

56329 (COO—4362-4, pp 1-4) **Geothermal geology of Arizona.** Hahman, W.R. Sr. Jul 1978.

In Low-temperature geothermal reservoir site evaluation in Arizona. Quarterly progress report, February 1—April 30, 1978.

The geology of both hydrothermal and hot-dry-rock systems in Arizona is discussed. (MHR)

56330 (COO—4362-4, pp 63-91) **Landsat lineament map of Arizona with emphasis on quarternary fractures.** Lepley, L.K. Jul 1978.

In Low-temperature geothermal reservoir site evaluation in Arizona. Quarterly progress report, February 1—April 30, 1978.

Regional lineaments were traced from Landsat photographs. Special attention was given to those believed to represent deep-seated crustal ruptures controlling recent igneous activity. Pre-Quaternary features were included because (1) the configuration of older structures is needed to define the magnitude of Quaternary plate motions; and (2) accessory data should be used to confirm ages of regional fracture or fault zones. An older lineament map was used to demonstrate optical Fourier processing. The new lineament map compares favorably with the tectonic models of Titley, Purvis, and Rehrig and Heidrick. Alignments of recent volcanoes with lineaments suggest NE and NW control on the Colorado Plateau and NNW and ENE control in the Sonoran Desert.

NON-USA

56331 (LBL—8905) **Vertical movement along the Cerro Prieto transform fault, Baja California, Mexico - a mechanism for geothermal energy renewal.** Vonder Haar, S.; Noble, J.E.; Puente Cruz, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Comision Federal de Electricidad, Mexico City). Mar 1979. W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

Data from 53 geothermal wells to depths of 1 to 3 km on either side of the right-lateral Cerro Prieto fault, as well as geophysical data, indicate vertical displacements of this fault of 400 to 600 m. This episoidic vertical movement has offset deltaic sandstone reservoirs that are primarily at 1200 m and 1800 m depth and contain 250° to 345°C water. A major fracture system for convective fluid movement has been thus maintained, with production at 150 MW.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 56336

56332 (COO—4362-4, pp 10-62) **Thermal gradient anomalies in southern Arizona. Report of Investigation 6.** Giardina, S. Jr.; Conley, J.N. (Arizona Oil and Gas Conservation Commission, Phoenix). Jul 1978.

In Low-temperature geothermal reservoir site evaluation in Arizona. Quarterly progress report, February 1—April 30, 1978.

A survey of the records of numerous thermally anomalous water wells in the southern portion of the Basin and Range province of Arizona indicates that most of these wells are less than 300 m deep. The temperature and depth data of most of these shallow wells produce abnormally high computed thermal gradients that are inconsistent with considerably lower gradients in deeper wells. Utilization of a method devised for an appraisal of shallow well data permits identification of the most attractive thermal gradient anomalies warranting additional data-gathering methods. Water moving vertically from deep-heated crustal rock along faults and then moving horizontally into relatively shallow basin-fill deposits seems to be the most probable explanation for the irregular but widespread occurrence of thermal ground water in the study area. A significant number of these occurrences appear to have thermal gradients potentially adequate for non-electrical energy utilization.

56333 (LA—7993-MS) **Thermal gradients and heat flow data in Colorado and Wyoming: a preliminary report.** Decker, E.R.; Bucher, G.J. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

Temperature gradient data and heat flow data are compiled for 23 core and rotary drill holes in the Rocky Mountains of Colorado and Wyoming. Gradients range from 10.7°C/km in the Medicine Bow Mountains, Wyoming, to 40.1°C/km in the San Juan Mountains, Colorado. Uncorrected heat flow ranges from 1.1 to HFU at Rawlins, Wyoming to 6.1 at Rico, Colorado.

GEOCHEMICAL TECHNIQUES AND SURVEYS

56334 (UCRL—52799) **Apparatus and techniques for the study of precipitation of solids and silica from hypersaline geothermal brine.** Hill, J.H.; Harrar, J.E.; Otto, C.H. Jr.; Deutscher, S.B.; Crampton, H.E.; Grogan, R.G.; Hendricks, V.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Jul 1979. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

The kinetics of precipitation reactions in geothermal brines can be studied accurately only if the brine samples are collected and examined under anaerobic conditions and with minimum cooling. Apparatus and techniques were developed that achieve this for brine temperatures below 100°C. The concentration of suspended solids is measured gravimetrically after filtration, and the concentration of dissolved silica is measured by atomic absorption spectrophotometry. Data from Woolsey No. 1 well of the Salton Sea Geothermal Field illustrate typical results of the procedures.

EXPLORATORY DRILLING AND WELL LOGGING

56335 (CONF-791020—1) **Evaluation of testing and reservoir parameters in geothermal wells at Raft River and Boise, Idaho.** Allman, D.W.; Goldman, D.; Niemi, W.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. Dep. NTIS, PC A02/MF A01.

From 9. annual Rocky Mountain ground-water conference; Reno, NV, USA (22 Oct 1979).

Evaluating the Raft River and Boise, Idaho, resources by pump and injection tests require information on the geology, geochemistry, surficial and borehole geophysics, and well construction and development methods. Nonideal test conditions and a complex hydrogeologic system prevent the use of idealized mathematical models for data evaluation in a one-phase fluid system. An empirical approach is successfully used since it was observed that all valid pump and injection well pressure data for constant discharge tests plotted as linear trends on semilogarithmic plots of borehole pressure versus time since pumping or injection began. Quantification of the pressure response prior to 600 minutes is not always possible. Short-duration (< 24-hour) injection or pump tests are conducted with the drilling rig equipment, and long-duration (21-day) injection and pump tests are then conducted with the permanent pumping facilities. Replicate instrumentation for pressure, temperature, and flow rates is necessary to ensure quality data. Water quality and monitor well data are also collected.

56336 **Preliminary studies of dry rock geothermal exploitation in south west England.** Batchelor, A.S.; Pearson, C.M. Camborne, England; Camborne School of Mines (1978). 18p. (CONF-7810189—1).

From Institution of mining and metallurgy special general meeting: mineral exploitation; St Ives, Cornwall, UK (4 Oct 1978).

A research program to develop a method to exploit the heat usually found in mines in the Cornwall area is described. Temperature gradients range from 27 to 34°C/Km with a mean of 29.8°C/Km. The exploitable area is defined and methods of creating an artificial geothermal field or artificial reservoir are described. Tests to determine fractures in rocks including gamma-gamma logging, tv

camera, caliper, and 3-D sonic are described as are pumping tests. 15 references, 3 figures.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 56343, 56344

56337 Geothermal energy legislation: the National Energy Act and new proposals. Stephens, R.C. pp 45-48 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Provisions of the National Energy Act which relate to geothermal energy are described. Further measures under consideration for a Geothermal Energy Omnibus Bill to be proposed in 1979 are discussed.

56338 Joint venturing for geothermal development. Perry, B.J. pp 75 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Southern California Edison's joint ventures with Getty Oil Company and also with Southern Pacific Land Company and Phillips Petroleum Company are reviewed briefly. (MHR)

56339 Preliminary report on the Northern California Power Agency's Notice of Intention to seek certification for NCPA Geothermal Project No. 2. Sacramento, CA; California Energy Resources Conservation and Development Commission (1978). 238p. (NP—23922). California Energy Resources Conservation and Development Commission, 1111 Howe Ave., Sacramento, CA.

This preliminary report on the Northern California Power Agency (NCPA) geothermal power plant proposal has been prepared pursuant to California Public Resources Code Sections 25510, 25512, and 25540. It presents the preliminary Findings of fact and Conclusions adopted by the Commission Committee assigned to conduct proceedings on the Notice. In addition, the report contains a description of the proposed project, a summary of the proceedings to date, and local, state, and Federal government agency comments on the proposal. Finally, the report presents the Committee's view of those issues that require further consideration in future proceedings on the Notice. Pursuant to Public Resources Code Sections 25512 and 25540, the report presents preliminary Findings and Conclusions on: (1) conformity to the forecast of statewide and service area electric power demands; (2) the degree to which the proposed site and facility conform with applicable local, regional, state and Federal standards, ordinances, and laws; and (3) the safety and reliability of the facility.

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 56360, 56361, 56362

56340 (CONF-790906—32) **Direct applications of geothermal energy market penetration analyses and infrastructure requirements.** Lunis, B.C.; Hanny, J.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 3p. Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council annual meeting; Reno, NV, USA (24 Sep 1979).

EG & G Idaho is performing geothermal market penetration analyses, and investigating infrastructure requirements. This paper provides a brief summary of some of the analyses being conducted to serve as a guide in the preparation of comprehensive plans for the accelerated commercialization of geotherm• energy.

56341 (UCRL—52763) **Social and economic research program for the Geysers-Calistoga known geothermal resource area.** Hall, C.; O'Banion, K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Mar 1979. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

The purpose of this study is to assess the economic and social effects of projected geothermal resource development for both direct use and electric power generation and to analyze local regulatory policy options designed to mitigate adverse effects. The key issues are land use, fiscal and public infrastructure systems, demography, and the local economy. The study has seven elements: a computer-based inventory and analysis of land characteristics, constraints, sensitivity, and suitability for various land uses; projections of direct and electric geothermal development; primary and induced economic activity using an input-output model; demographic changes; the land and infrastructural demand created; an assessment of the economic and social effects of various configurations in land use that could result; and an analysis of various local regulatory policy options to mitigate adverse effects. The study is a cooperative effort among two national laboratories, a regional agency, and the four Geysers-area counties (Lake, Mendocino, Napa, and Sonoma). The assessment results are intended to guide Department of Energy planners on the environmental consequences of program implementation. The regulatory policy analysis is intended for local officials who are implementing development-management policy.

56342 Financing and construction of a commercial geothermal power plant in Utah. Rogers, H.I. (Rogers Engineering Co., Inc., San Francisco, CA). pp 39-42 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Financing and construction aspects of a geothermal project in Utah are presented. Market conditions, DOE loan guaranty, steam costs, and power plant investor costs make up the energy selling price.

56343 Federal geothermal loan guaranty and pending programs. Magliano, V.A. (Dept. of Energy, San Francisco, CA). pp 49 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

A brief general overview of the Department of Energy's (DOE) Geothermal Loan Guaranty Program (GLGP) is provided. Areas to be covered include: program objectives and scope; the status of the GLGP; DOE's processing of a loan guaranty application; recent GLGP legislation; proposed regulations; and new program initiatives.

56344 Structuring of geothermal development loans. Woods, J.H. pp 51-54 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Until recently, the Geothermal Industry has not attracted the financial community because of its infancy and inherent risk problems. The Congress recognized the need to attract proper financial assistance in order to escalate the development of geothermal resources and enacted the Geothermal Loan Guaranty Program (GLGP) under Title II of the Geothermal Energy Research, Development and Demonstration Act of 1974. This guaranty program is administered by the United States Department of Energy. (DOE)

56345 Leveraged leasing of a geothermal power plant. Panawek, G. Jr. (ITEL Corp., San Francisco, CA). pp 55-58 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

The total United States inventory of leased equipment is now over $80 billion. The tax leveraged lease is a viable form of project finance for the geothermal industry. This technique involves three parties: a lessor (equity investor), a lessee (equipment user), and a lender. The tax benefits are transferred to the lessor which are shared with the lessee through reduced financing costs. The tax leveraged lease resolves the four major obstacles associated with financing geothermal power plants. These problems are: (1) the resource developer or public utility has a capitalization or budgetary constraint, (2) the public utility does not want to assume all the risks associated with the construction and operation of the plant, (3) the public utility can not utilize all the tax benefits generated through ownership of the plant, and (4) the resource developer does not want to be regulated. It is essential that a qualified lease underwriter be involved early to act as advisor and to ensure the proper preparation of this project financing of a geothermal power plant.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

56346 (EGG—2001(Vol.1)) **Potential use of geothermal resources in the Snake River Basin: an environmental overview. Volume I.** Spencer, S.G.; Russell, B.F.; Sullivan, J.F. (eds.). (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 85p. Dep. NTIS, PC A05/MF A01.

Environmental baseline data for the Snake River Plain known geothermal resource areas (KGRAs) are evaluated for geothermal development. The objective is to achieve a sound data base prior to geothermal development. These KGRAs are: Vulcan Hot Springs, Crane Creek, Castle Creek, Bruneau, Mountain Home, Raft River, Island Park, and Yellowstone. Air quality, meteorology, hydrology, water quality, soils, land use, geology, subsidence, seismicity, terrestrial and aquatic ecology, demography, socioeconomics, and heritage resources are analyzed. This program includes a summary of

environmental concerns related to geothermal development in each of the KGRAs, an annotated bibliography of reference materials (Volume II), detailed reports on the various program elements for each of the KGRAs, a program plan identifying future research needs, and a comprehensive data file.

56347 (EGG—2001(Vol.2)) **Potential use of geothermal resources in the Snake River Basin: an environmental overview. Volume II. Annotated bibliography.** Spencer, S.G.; Russell, B.F.; Sullivan, J.F. (eds.). (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 90p. Dep. NTIS, PC A05/MF A01.

This volume is a partially annotated bibliography of reference materials pertaining to the seven KGRA's. The bibliography is divided into sections by program element as follows: terrestrial ecology, aquatic ecology, heritage resources, socioeconomics and demography, geology, geothermal, soils, hydrology and water quality, seismicity, and subsidence. Cross-referencing is available for those references which are applicable to specific KGRA's. (MHR)

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 56328, 56342

56348 (COO—4051-46) **Geothermal energy in Iceland. A trip report: June 16-21, 1979.** Kestin, J. (Brown Univ., Providence, RI (USA)). Aug 1979. Contract EY-76-S-02-4051. 30p. Dep. NTIS, PC A03/MF A01.

The geothermal installations in Iceland are reviewed. The difficulties experienced with seismic and volcanic activity are discussed. A brochure published by The Krafla Geothermal Project Executive Committee is included. (MHR)

56349 **Development plans for the BACA Demonstration Program.** Maddox, J.D. (Public Service Co. of New Mexico, Albuquerque). pp 71-74 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

The US Department of Energy announced on July 6, 1978 that it had selected the Baca Geothermal Demonstration Project for cooperative development as proposed by Union Oil Company and the Public Service Company of New Mexico. In accordance with the proposal, Union will drill the required wells and will construct and operate the pipelines, separators, and other surface facilities required to supply clean dry steam to the generating plant. The generating plant will be constructed and operated by PNM. PNM will also construct the transmission facilities required to connect the plant to the company's existing transmission network. The total cost of the project, including operating and maintenance costs during the first five years of demonstration operations, is estimated to be slightly in excess of $100 million. Of this amount, DOE has been asked to contribute a maximum of approximately $45-$50 million. The balance of future project costs will be incurred approximately equally by Union and PNM.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

56350 (IDO—1603-1) **Geothermal and geopressure blowout control. Phase I. Study of existing technology. Phase II. Program plan for geothermal and geopressure blowout control.** Rehm, W.A.; Goins, W.C. Jr. (Maurer Engineering, Inc., Houston, TX (USA)). Nov 1978. Contract EG-76-C-07-1603. 276p. Dep. NTIS, PC A13/MF A01.

Four papers on existing technology and program planning for blowout control in geothermal and geopressured systems are included. Separate abstracts were prepared for each. (MHR)

56351 (IDO—1603-1, pp 119p, Geothermal Phase I) **Geothermal blowout control. Phase I. Study of existing technology.** Rehm, W.A.; Goins, W.C. Jr. Nov 1978.

In Geothermal and geopressure blowout control. Phase I. Study of existing technology. Phase II. Program plan for geothermal and geopressure blowout control.

The following are discussed: causes of well blowouts; well-control procedures; well-control equipment; job responsibilities, training, and regulations; economic consideratios related to well control, and recommendations. Technology transfer from oil and gas drilling are covered and procedures are described by reservoir type. (MHR)

56352 (IDO—1603-1, pp 94p, Geopressure Phase I) **Geopressure blowout control. Phase I. Study of existing technology.** Rehm, W.A.; Goins, W.C. Jr. Nov 1978.

In Geothermal and geopressure blowout control. Phase I. Study of existing technology. Phase II. Program plan for geothermal and geopressure blowout control.

Geopressure drilling is hazardous because of the pressures and gas that will be encountered. The hazard is compounded by the great depth of the wells and the difficulty in properly interpreting the well conditions. The present state-of-the-art provides no guaranteed safe and assured manner to drill the very high pressured geopressured well. Safeguards do exist that reduce the hazard to what has been economically acceptable. The equipment, techniques, and guidelines that have been developed for drilling into high pressure and geopressured zones are complete and adequate for their purpose - drilling for high pressured oil and gas fields. Equipment to detect the potential blowout in its earliest stages is unreliable and needs improvement. The standards on well-control equipment do not encompass the higher temperatures postulated for geopressure water and gas production and so the temperature limits need to be examined. The real key to geopressure drilling lies in well site supervision and well programming.

56353 (IDO—1603-1, pp 30p, Geothermal Phase II) **Geothermal blowout control. Phase II. Program plan for geothermal blowout control.** Rehm, W.A.; Goins, W.C. Jr. Nov 1978.

In Geothermal and geopressure blowout control. Phase I. Study of existing technology. Phase II. Program plan for geothermal and geopressure blowout control.

A comprehensive program to improve blowout control procedures and equipment in geothermal drilling is presented. The objective of the outlined program is to develop the elements that will lead to a more assured safe drilling program. Areas addressed in this study involve training and drills, procedures, and equipment where shortfalls are evident in blowout control operations for geothermal drilling.

56354 (IDO—1603-1, pp 24p, Geopressure Phase II) **Geopressure blowout control. Phase II. Program plan for geopressure blowout control.** Rehm, W.A.; Goins, W.C. Jr. Nov 1978.

In Geothermal and geopressure blowout control. Phase I. Study of existing technology. Phase II. Program plan for geothermal and geopressure blowout control.

A program to improve blowout control procedures and equipment in geopressure drilling is presented. The object of the outlined program is to develop the program. Areas addressed in this study involve training and drills, procedures, and equipment where shortfalls are evident in blowout control.

56355 (SAND—79-7084C) **Improvements in rotary seals for downhole motors in geothermal applications.** Wilson, J.G.; Tibbitts, G.A.; Black, A.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-790906—30). Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council annual meeting; Reno, NV, USA (24 Sep 1979).

The major limitation of downhole mud motors for geothermal well drilling as well as straighthole and oil well drilling is the bearing section. Reduced bearing life has been a direct result of the inability to seal lubricant in the bearing section. A reliable rotary seal is needed to extend bearing life and to allow high pressure drops across the drill bit for improved bottomhole cleaning and increased drilling rate. The endurance of high temperature rotary seal candidates is being measured in a full-scale laboratory seal tester capable of simulating the pressures and temperatures of geothermal well drilling. A description of the currently most successful high temperature seals and seal test results and findings are presented.

56356 (SAND—79-7085C) **Evaluation of high temperature lubricants for downhole motors in geothermal applications.** DeLafosse, P.H.; Tibbitts, G.A.; Green, S.J. (Terra Tek, Inc., Salt Lake City, UT (USA)). 1979. Contract EY-76-C-04-0789. 4p. (CONF-790906—29). Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council annual meeting; Reno, NV, USA (24 Sep 1979).

A Bearing-Seal Package is being developed for use with downhole motors and turbines for drilling geothermal wells. The lubricant will be sealed in the bearing section which will allow the bearings to operate directly in the lubricant. The development of the Bearing-Seal Package involves the improvement of high temperature seals and lubricants. Candidate high temperature lubricants were tested in the High Temperature Lubricant Tester under elevated temperatures and pressures. A list of candidate high temperature lubricants, a description of the lubricant test program, and the lubricant test results are presented.

56357 (SAND—79-7091C) **High temperatue clay chemistry.** Guven, N.; Carney, L.L. (Texas Tech Univ., Lubbock (USA). Dept. of Geosciences; Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 3p. (CONF-791041—2). Dep. NTIS, PC A02/MF A01.

From Workshop on geothermal drilling fluids; Houston, TX, USA (9 Oct 1979).

Hydrothermal experiments with clays such as sepiolite, attapulgite, saponite, and bentonite are described briefly. Rheological and minerological changes were studied in the clays subjected to hydrothermal treatments with and without the addition of the salts and the hydroxides of Na, K, Ca, and Mg. (MHR)

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 56334

56358 (BNL—51036) **Alternate materials of construction for geothermal applications. Progress report No. 18, January-March 1979.** Steinberg, M.; Kukacka, L.E. (Brookhaven National Lab., Upton, NY (USA)). Aug 1979. Contract EY-76-C-02-0016. 48p. Dep. NTIS, PC A03/MF A01.

Progress in a program to develop non-metallic materials for use in geothermal processes is described. To date, several high temperature polymer and polymer concrete systems were formulated, laboratory and field tests were performed in brine, flashing brine, and steam at temperatures up to 260°C (500°F), and economic studies were started. Laboratory data for exposure times > 2 years are available. Results are also available from field exposures of up to 24 months in five geothermal environments. Good durability is indicated. Testing at five of these sites is continuing and plans to initiate tests at other sites are being implemented. Work was also started to develop materials for use in high temperature seals for well drilling, logging and energy extraction processes.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 56348

56359 (DOE/ET/01102—6) **Expansion of the Geo-Heat Quarterly Bulletin. Final report, 15 June 1978-30 June 1979.** Lienau, P.J. (Oregon Inst. of Tech., Klamath Falls (USA)). 1979. Contract ET-78-S-06-1102. 80p. (RLO—1102-6). Dep. NTIS, PC A05/MF A01.

The work of the Center is described in the areas of: public information dissemination service, technical assistance to developers, regional resource planning, and applied research projects. Included in the appendix are four issues of the Geo-Heat Utilization Center Quarterly Bulletin. (MHR)

56360 **Space conditioning with geothermal energy.** Lienau, P.J. (Oregon Inst. of Tech., Klamath Falls). pp 23-26 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Space heating energy requirements for US buildings is approximately 14 Quads annually. (Quad = 10^{15} Btu). It is estimated that geothermal energy could potentially supply 3.4% of this demand, which represents a benefit to about 10% of the US population which lives within forty miles of 224 known geothermal resources in eleven western states. Technically it is feasible to pipe hot water 40 miles; however, economic limitations are low load factors for space heating and insulated pipeline cost. Load factors can be increased with the use of absorption air-conditioning units and industrial processing. Conventional forced-air, convector, radiant panel and heat pump heating systems are adaptable to geothermal energy for space heating and cooling. In all the international examples of district heating, the cost of the geothermal utilization is below that of comparable fossil fuel energy, and will be more competitive with future rises in fossil fuel costs.

56361 **Geothermal energy market potential in industrial processing.** Schultz, R.J.; Hanny, J.A.; Knuth, W.H. (Idaho National Engineering Lab., Idaho Falls). pp 27-30 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

Geothermal energy is currently being used for a number of industrial processes in countries throughout the world. Its application in the United States is mainly limited to space heating even though the temperature of the geothermal fluid is sufficient for process uses, and could be sold at attractive prices while maintaining a high return on investment. The temperature span for industrial use ranges from 40°C to 275°C, thus encompassing both the abundant low temperature and the less available high temperature resources. Hydrothermal fluids can be used either directly or indirectly dependent upon fluid quality and process needs. The barriers facing hydrothermal industrial process development are (a) the development infrastructure does not exist, (b) energy users are not aware of hydrothermal energy and its advantages, (c) federal incentives are limited, (d) resouces are not fully defined.

56362 **Economics of direct use geothermal energy for process and space heating.** Higbee, C.V. (Oregon Inst. of Tech., Klamath Falls). pp 31-34 of Commercialization of geothermal resources. Davis, CA; Geothermal Resources Council (1978).

From Conference on commercialization of geothermal resources; San Diego, CA, USA (28 Nov 1978).

The inflation rates of conventional fuels forecast over the next 20 years are used to evaluate process and space heating applications of direct use energy. Federal tax incentives provided by the 1978 legislature are included where appropriate to present a more accurate economic model. All studies are site specific. Process heating includes onion dehydration and potato processing in Oregon. Space heating considers commercial use for a 15-acre greenhouse complex and a 200-bed hospital in Klamath Falls, Oregon and district residential heat in Reykjavik, Iceland and Boise, Idaho.

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 56334

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 56357

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

56363 (UCRL—82531) **Application of autospectral and regression analysis to the study of temporal-spacial variation of winds in complex terrain.** Porch, W.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jun 1979. Contract W-7405-ENG-48. 7p. (CONF-791031—1). Dep. NTIS, PC A02/MF A01.

From 6. conference on probability and statistics in atmospheric sciences; Banff, Alberta, Canada (9 Oct 1979).

How many meteorological stations, where they should be placed and how often the data should be taken to characterize wind flow in complex terrain continues to be a problem for pollution transport studies as well as wind energy prospecting. A two month (June and July 1978) field study was conducted using laser anemometers (Lawrence, et al., 1976) across a windy pass (Patterson Pass) about 60 km east of San Francisco, California. These measurements were supported by data from over 50 meteorological stations throughout the Bay Area and Central Valley. Power spectral analysis was applied to the two month data period (Blackman and Tukey, 1958) for 1152 thirty minute averages and a Tapered Entropy Method (Strand, 1975) for 54 hourly averages at the minimum and maximum of the diurnal sea-breeze cycle). The results of the spectral analysis indicates an ~ 6 and ~ 12 day cycle in summer-sea breeze intensity throughout the region, as well as, pointing out fundamental differences between spacially averaged winds (such as are required by numerical models) and point wind measurements in complex terrain.

ECONOMICS

REFER ALSO TO CITATION(S) 56298

WIND ENERGY ENGINEERING

APPLICATIONS

REFER ALSO TO CITATION(S) 56298

TURBINE DESIGN AND OPERATION

56364 **Techniques for stabilizing wind turbine generators connected to power systems.** Hwang, H.H.; Guo, T.; Mozeico, H.V. (Univ. of Hawaii, Honolulu). pp 7p, Paper A 78 280-0 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Enginners, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

This study presents an analytical representation of a wind turbine generator which employs blade pitch angle feedback control. A mathematical model is formulated. With the functioning Mod-O wind turbine (ERDA-NASA 100 kW unit) serving as a practical

case study, results of a computer simulation of the model as applied to the problem of dynamic stability at rated load is presented. The effect of the tower shadow is included in the input to the system. Different configurations of the drive train, and optimal values of the tie line are used in the simulations. Computer results reveal that a static excitation control system coupled with optimal values of the tie line will effectively reduce oscillations of the power output, without the use of a slip clutch. 8 references.

POWER CONVERSION SYSTEMS

56365 Wind-driven, capacitor-excited induction generators for residential electric heating. Mohan, N.; Riaz, M. (Univ. of Minnesota, Minneapolis). pp 6p, Paper A 78 050-7 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

A scheme using a wind-driven, capacitor-excited induction generator is described to supply frequency-insensitive heating loads. Despite the wide variation in rotor speed, the slip remains small, thereby providing a high-efficiency operation. The electric power output can be controlled over a substantial range to match the wind-turbine speed-power characteristic, by adjusting the excitation-capacitance. A steady-state analysis of self-excitation is presented, upon which the calculations are based. Comparison of the predicted behavior with the experimental results shows good agreement between the two. A variable-capacitor excited squirrel-cage induction generator can provide a reliable and relatively inexpensive means to generate electrical power from the wind, for such frequency-insensitive loads as space and water heaters. 4 references.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 56752, 56809, 56810

56366 (AD-A—062078) **Theoretical and experimental study of superconducting inductive storage systems. Final report, August 1976-July 1978.** Mawardi, O.K.; Hazony, D.; Chung, H.K.; Holland, L.D. (Case Western Reserve Univ., Cleveland, OH (USA). Plasma Research Lab.). 17 Oct 1978. 127p. NTIS PC A07/MF A01.

The report covers a two year effort to develop efficient pulse inductive storage sources. Two schemes have been considered in details. One scheme is based on the electromagnetic dual of the classic Marx generator. In the other scheme a pulse shaping circuit has been used to improve the energy transfer from the storage to the load. In the process of these investigations two types of flux pumps have been investigated. These superconducting devices are ideal to provide the charging current to the inductors. Fast acting pumps were designed and built. Their response is several orders of magnitude better than is currently available.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

56367 (AED-Conf—77-561-004) **Construction and plume observation on a dry/wet test cell in the Marbach III power plant.** Beising, R. (Energie-Versorgung Schwaben A.G., Stuttgart (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 9p. (In German). (CONF-771262—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Technical meeting on cooling tower operation; Duesseldorf, F.R. Germany (2 Dec 1977).

Using a wet/dry prototype cooling tower in addition to the existing wet cooling tower cells, the possibility was given in Marbach to study this new cooling technique which had not been tested before in the Federal Republic. It was found that combined cooling with plastic heat exchangers is a promising way to shorten the plumes, although in varying degrees, and to save water due to lower evaporation losses. It should be noted, however, that the plume behaviour observed cannot be used to draw conclusions on high-power dry/wet cooling towers, e.g. for a 1300 MW power plant unit.

COMPONENTS

REFER ALSO TO CITATION(S) 56380

WASTE HEAT UTILIZATION

56368 Energy economizer for low temperature stack gas--a case study. Tipton, J.A.; Hughes, K.J. (US DOE, Bartlesville Energy Res Cent, Okla). pp vp of American Institute of Plant Engineers (AIPE) annual convention. Cincinnati, OH; American Inst. of Plant Engineers (1978).

From American Institute of Plant Engineers; Dallas, TX, USA (12 Jun 1978).

In an effort to investigate the potential of recovering energy from low temperature stack gas, engineers at the Bartlesville Energy Research Center designed and built an air preheater supplying a hot water generator in the BERC Central Power Plant. A new stack assembly to accommodate an air preheater system was designed by BERC engineers and fabricated at a commercial metal shop. Initial results show reduction of about 6-7 percent in fuel consumption at all operating ranges. At full-load conditions, incoming combustion air is preheated to 250°F above ambient temperature. There is no evidence of corrosive effects after about 2 years of operation, and BERC management is optimistic that a general application of this concept can contribute to programs designed to recover waste stack gas energy.

FUELS

REFER ALSO TO CITATION(S) 55948, 55967

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 57113, 57128

THERMAL EFFLUENTS

56369 (N—79-13036) **Helicopter mission optimization study. Final report.** Olson, J.R. (United Technologies Corp., Stratford, CT (USA). Sikorsky Aircraft Div.). Dec 1978. Contract NAS1-1498. 122p. NTIS PC A05/MF A01.

The feasibility of using low-cost, portable computer technology to help a helicopter pilot optimize flight parameters to minimize fuel consumption and takeoff and landing noise was demonstrated. Eight separate computer programs were developed for use in the helicopter cockpit using a hand-held computer. The programs provide the helicopter pilot with the ability to calculate power required, minimum fuel consumption for both range and endurance, maximum speed and a minimum noise profile for both takeoff and landing. Each program is defined by a maximum of two magnetic cards. The helicopter pilot is required to key in the proper input parameter such as gross weight, outside air temperature or pressure altitude.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 55989, 56007, 56013, 56014

56370 (PB—289946) **Fabric filter cost for large coal-fired steam generators. Final report.** Bruck, J.; Noe, N.D. (Industrial Gas Cleaning Inst., Inc., Stamford, CT (USA)). Aug 1977. Contract EPA-68-02-2532. 22p. NTIS PC A02/MF A01.

Capital and annualized costs are provided by vendors for fabric filters used for particulate emission control of large coal-fired steam generators. Generator sizes of 200, 500, and 700 MW are considered at an emission level of 14.3 ng/J (0.033 lbs/million Btu) both equipment and turnkey costs are provided.

56371 Comparative evaluation of cells for ash resistivity measurement. Nevens, T.D. (Denver Research Institute, CO); Culbertson, W.J. Jr.; Tassicker, O.J. pp 7p, Paper A 78 304-8 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

Recommended procedures for measurement of particulate resistivity have been available for some time; it was considered opportune to review these procedures in the light of the considerable effort which has taken place around the world. Based on previous experience, three general types of laboratory resistivity cells were chosen for review. They included the following: coaxial cell with guard rings; parallel plate cell without guard ring; and parallel plate cell with guard ring. Because of the large quantity of data required to be collected and processed in the study and the desirability of imposing reproducible conditions for testing, a completely automated system was designed incorporating a mini-computer. The principle conclusions from the study include: the parallel plate cell and the coaxial cylindrical cell can be constructed and operated in such a manner as to give consistent results and results which generally

agree with each other; thus, choosing the best cell became a subjective study in analyzing the advantages and disadvantages of each cell; and considering the merits of each of the three cells tested, it is concluded that the parallel plate cell with the guard ring can provide satisfactorily reproducible results and is simplest to construct.

56372 Fuel and ash evaluation to predict electrostatic precipitator performance: A progress report. Wagoner, C.L.; (The Babcock & Wilcox Company, Alliance, OH); Barrick, S.M.; Vecci, S.J.; Piulle, W. pp 4p, Paper A 78 305-5 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

Solid fuel samples as small as 2.3 kg (5 pounds) are pulverized and combusted using suspension firing conditions that simulate those found in full-scale utility boilers. The resulting fly ash is characterized using laboratory procedures. These analyses are intended to aid in predicting the performance of electrostatic precipitators. The Electric Power Research Institute (EPRI) is sponsoring this work to produce an improved fuel evaluation procedure and to establish a standard testing facility available to all.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 56260

56373 (AD-A—061742) **Feasibility of isolating vulnerable equipment of the electric power system from sources of EMP. Final report.** Stanek, E.K. (Emergency Electric Power Administration, Washington, DC (USA)). Mar 1978. Contract DCPA01-76-C-0290. 102p. NTIS PC A06/MF A01.

The report evaluates the feasibility of isolating vulnerable equipment of the electric power system from sources of electromagnetic pulses (EMP) through the use of supervisory control and dispatched personnel to perform remote and manual switching, respectively, in distribution substations. The data contained in this report were obtained primarily through interviews of electric utility personnel. The conclusion drawn from these data is that it is possible to isolate a significant portion of the vulnerable equipment in the distribution system from sources of EMP. This would not only reduce the number of failures of equipment in the distribution system (and hence system faults), but would also configure the system in a more secure state with respect to electromechanical stability. Problems associated with the transition from the normal system state to the new operating state and the restoration of service to loads after the attach are discussed. The report also contains information on the development of a new lightning arrester design that has better EMP characteristics than existing designs.

56374 IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978). 1091p. (CONF-780142—). The Publisher, 345 East 47th St., New York, NY.

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

A separate abstract was prepared for each item in scope for the Energy Data Base. (HDR)

56375 Investigation of insulating materials for high-temperature gas insulated systems. Tahiliani, V.H. (Electric Power Research Institute, Palo Alto, CA), Reighter, D.H. pp 5p, Paper A 78 191-9 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

The power ratings of gas cables can sometimes be substantially increased if, among other things, the components of the gas insulated systems, primarily the solid insulators, can be designed for high temperature operation. Current development work on an insulation system for this is presented. A materials screening program, and the results on tested insulating materials are covered. Through a simple, low voltage apparatus, a novel approach to test solid insulating materials for track-resistance within an SF_6 environment is also described.

56376 Battery energy storage test (BEST) facility: its purposes and description. Beck, J.W. (Electric Power Research Inst., Palo Alto, Ca); Smith, J.C. pp 7p, Paper A 76 488-7 of IEEE Power Engineering Society Text of "A" papers from the summer meeting. New York, NY; Institute of Electrical and Electronic Engineers, Inc. (1976).

From IEEE Power Engineering Society; Portland, OR, USA (18 Jul 1976).

The concept of a facility for testing and evaluating batteries for load leveling applications on electric utility systems has been examined and found feasible by a joint utility Industry/Government study team. Following the team's recommendation, the Electric Power Research Institute (EPRI) and the US Energy Research and Development Administration (ERDA) are currently working with the host utility selected as the prime contractor for engineering design, construction and operation. The facility proposed and its design criteria, to accommodate such detailed testing are described. The purposes and objectives of the facility, and the battery systems expected for testing in the facility are reviewed. Discussion of the BEST Facility program - both past and current activities - and its scheduled and cost estimates is included.

AC SYSTEMS, EHV AND UHV

56377 (EPRI-EL—1047-SR, pp 1.1-1.17) **Reactors and capacitors controlled by thyristors for optimum power system VAR control.** Engberg, K.; Torseng, S. (ASEA-ATOM AB, Vaesteaas, Sweden). Apr 1979.

From Transmission static VAR systems seminar; Duluth, NM, USA (24 Oct 1978).

Some different static var system (SVS) applications are reviewed. Two basic schemes for thyristor-controlled static compensators are described, namely thyristor switched capacitors (TSC) and thyristor-controlled reactors (TCR). A more advanced scheme using a combination of TSC and TCR is also described. It is shown that this combination given a greater degree of flexibility when designing a compensator. The losses can be minimized at the normal operating point and the harmonics can be kept at a lower level. The TSC and the combination system of TSC and TCR also offers an inherent redundancy as the compensator normally comprises parallel branches. The first compensator systems in the world based on the combined TSC/TCR principle are now under delivery for installation in power transmission systems and are discussed in some more detail.

56378 Optimization of single conductor gas-insulated transmission systems. Cronin, J.C. (Gould Inc., Greensburg, PA); Hughes, P.S.; Samm, R.W.; Tahiliani, V.H. pp 5p, Paper A 78 189-3 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

Gas-insulated transmission systems built to date have been designed on a dielectrically optimized basis. As higher power levels are encountered this is no longer the most efficient way to design systems, and optimization must be accomplished on an economic basis. A logical, systematic design sequence is followed to allow an optimum balance to be achieved between hardware costs, installation cost and cost of losses. It is shown that, for each voltage level, there is an optimum power transmission level. Losses are found to account for approximately 27% of the cost of optimized designs, on a present worth basis. Higher dielectric stresses allow cost reductions of up to 10% to be achieved at lower power levels. However, as power levels increase thermal affects begin to dominate and full advantage cannot be taken of higher stress levels. Lower thermal resistivity backfill has considerable potential and allows cost reductions in excess of 10% at the higher power levels.

56379 Design of a power system simulator. Carlsen, K. (Energy Research and Development Administration, Washington, DC); Carroll, D.P.; Gareis, G.E.; Nozari, F.; Krause, P.C.; Ong, C.M.; Triezenberg, D.M. pp 8p, Paper A 78 240-4 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

The design of a special purpose power simulator is described. Primarily, this simulator consists of hardwired modules of analog computer components which are used to simulate various power system components. This special purpose or dedicated computer is designed to be used in combination with a general purpose hybrid computer. In the simulator, three-phase network representation is used in conjunction with recognized machine, exciter, prime mover, and ac-dc converter models. This type of representation is applicable primarily to the investigation of power system problems involving the electromechanical characteristics, machine-network interactions, and control techniques for improving system security.

56380 New armature winding concepts for ehv and high cfct applications of superconducting turbine generators. Flick, C. (Westinghouse Electric Corp., East Pittsburgh, PA). pp 9p, Paper A 78 313-9 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

The potential of superconducting turbine generators to benefit the design of electric utility power systems in new and exceptional ways has been appreciated for a number of years. Potential benefits include major reductions in losses and capital costs, possibilities of designing for exceptionally high voltage ratings, and improved transient stability performance. New armature winding concepts are required for the full realization of this potential. This paper describes a new armature winding geometry, whose variant forms lend themselves particularly well to: the use of insulating materials and practices such as are used in compact high-voltage apparatus; uniform and continuous support for the armature coils and end turns; and simple manufacture. Applications of this geometry to high-voltage and low-voltage armature windings, some of the economic benefit obtainable from these, and development plan directed towards achieving commercial status are also described.

56381 **Substation ground grid resistance measurements: low voltage testing techniques.** Hall, R. (Bonneville Power Administration, Portland, OR). pp 8p, Paper A 76 460-6 of IEEE Power Engineering Society Text of "A" papers from the summer meeting. New York, NY; Institute of Electrical and Electronic Engineers, Inc. (1976).

From IEEE Power Engineering Society; Portland, OR, USA (18 Jul 1976).

The accuracy and adequacy of ground resistance measurements obtained with low voltage equipment has been a question of long standing. Methods and techniques necessary in the test procedure to obtain low voltage power source measurements comparable to those obtained using a high voltage power source are described.

NUCLEAR POWER PLANTS

56382 (INIS-mf—4280, pp 9-23) **Twenty years of the Nuclear Research Institute and its contribution to the development of nuclear power and technology in Czechoslovakia.** Havel, S. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

A survey is presented of the most important results of scientific research efforts of the Nuclear Research Institute (UJV) attained in the 20 years of the Institute's existence. In 1975 the proportion of the individual fields of research was as follows: reactor technology 37%, reactor materials 19%, nuclear fuel processing including waste processing 18%, ionizing radiation applications 16%, others 10%. In the field of reactor technology, orientation is evident to light-water and fast reactors (1975): light-water reactors 40%, fast reactors 44%, heavy-water reactors 16%. The most significant contribution of the Institute to the first Czechoslovak nuclear power plant A-1 in the past period included the construction of the TR-0 heavy-water critical assembly, the choice of suitable uranium alloys and their thermal and mechanical treatment for the A-1 fuel elements, corrosion and mechanical stability study of cladding materials and post-irradiation fuel study performed in the UJV hot chambers.

56383 (INIS-mf—4442) **Nuclear Energy: General aspects of risk assessment and public acceptance.** Fischerhof, H. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 9p. (In German). (CONF-7710201—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Nuclear Inter Jura 1977; Florence, Italy (2 Oct 1977).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 56600, 56602, 56637, 56639, 56659, 56660, 56678, 56705, 56718, 56898

56384 (AED-Conf—78-011-000, pp 1-2) **Neutron-physical layout of BWR fuel elements containing Pu: method of calculation and experimental verification.** Ambrosius, G.; Stein, H. (Kraftwerk Union A.G., Frankfurt am Main (Germany, F.R.)). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56385 (CEGB-RD/B/N—4268) **Formation and break-up of corrosion product agglomerates in the primary coolant of water reactors.** Means, F.A. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Apr 1978. 24p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Simple theories for the formation and break-up of agglomerates are used to examine the likely effects on the deposition behaviour of particulate corrosion products in PWR, BWR and SGHWR primary coolant circuits. The effect of sample lines on the measured particle size distribution is also considered for the specific case of Winfrith SGHWR.

56386 (CONF-770807—, pp vp) **Containment system selection.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56387 (CONF-770807—, pp vp) **Composite containment for nuclear power.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new concept is described in which a steel liner is employed which carries much of the primary membrane loads. This type of structure is similar in some aspects to the previously described system: a mat, lined with a thin plate on its top surface, is similar to concrete containment; a cylinder and hemispherical dome, made up of steel plate and concrete, is is about 2.5 feet thick (the minimum required for radiation shielding). The governing equations have been derived accounting for the fact that the stresses in the steel liner are calculated in accordance with the shell equations for hoop and meridional strains and temperature and the fact that the reinforcing bars respond as linear members. Because of composite behavior hoop and meridional membrane strain compatibility is maintained between the steel liner and the reinforcing bars.

56388 (CONF-770807—, pp vp) **Design, analysis and construction of the prestressed concrete containment of the nuclear power station Gundremmingen.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Kraftwerk Union AG is presently constructing at Gundremmingen (Bavaria) on the River Danube a BWR twin-plant (KRB Units B and C) with a capacity of 2x1300 MWe. Owing to the wall thickness/diameter ratio the containment can be calculated as a thin-walled shell. Areas of discontinuity are subjected to three-dimensional investigations. For the design of the concrete structure different fracture safety margins are defined for the load conditions occurring in operation in the event of a loss-of-coolant accident and as a result of an aircraft or an earthquake.

56389 (CONF-770807—, pp vp) **Preliminary design of a containment to withstand core melt for a 1,100 MWe LWR system.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56390 (CONF-790935—3) **Fission product release from LWR fuel defected in steam in the temperature range 500 to 1600°C.** Lorenz, R.A.; Collins, J.L.; Osborne, M.F.; Malinauskas, A.P. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From IAEA specialists meeting on defected zirconium alloy clad ceramic fuel in water cooled reactors; Chalk River, Canada (17 Sep 1979).

For practical purposes the release of cesium and iodine from LWR fuel rods in the temperature range 500 to 1600°C can be considered to originate from three sources: (1) the gap inventory with release by both burst (vented gas) and diffusion; (2) grain boundary with release by tunnel formation; and (3) UO_2 matrix with release by solid state diffusion. The chemical behavior of released iodine and cesium (at least after contact with steam) is predominantly that of CsI and CsOH. Fission gas release is the sum of the plenum inventory, gas embedded in the fuel and cladding surface layers and that released by tunnel formation, and solid state diffusion from the UO_2 matrix. A small amount of large particle-sized fuel dust is ejected at time of rupture.

56391 (INIS-mf—4241) **Integrated leak rate testing for containment integrity.** Roman, W.D. (Ebasco Services, Inc., New York (USA)). 1978. 8p. (CONF-7710184—17). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

Prior to the receipt of an operating license in the United States for all water-cooled power reactors, a primary containment integrated leak rate test (ILRT) must be performed. This test must satisfy the requirements as outlined in the Code of Federal Regulations, Title 10, Part 50, Appendix J. The impact that both existing and proposed regulatory requirements have on this testing and the degree of sophistication with respect to instrumentation and control that is required to satisfy these requirements are discussed.

56392 (INIS-mf—4247) **Development of a computerized operation manual for nuclear power plants.** Roggenbauer, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Forschungszentrum). 1978. 13p. (CONF-7710184—16). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

A problem arose during the licensing work for the reactor protection system (RPS) and the safety systems of the first Austrian nuclear power plant at Zwentendorf. It could have severe impact to the overall safety of the plant and the environment. The first Austrian nuclear power plant has a boiling water reactor with 723 MW(e) power and the installed RPS is a convertional dynamic selfchecking 2 out of 3 relay system. One approach, employing a computer which appeared to be the most suitable for attacking this problem is described. The merits and the obtectives of using a computer are explained. The ideas of how to gradually develop a computerized system which should be an aid to the reactor operator and can be implemented in a already operating plant without any conceptual changes are reflected.

56393 (INIS-mf—4252) **Some modifications in the protection system of a BWR caused by fire protection requirements.** Nedelik, A. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Forschungszentrum). 1978. 6p. (CONF-7710184—13). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

A group of experts have been nominated by licensing authorities to work out fire protection recommendations for the first Austrian nuclear power plant. These requirements necessitated a number of modifications in design and lay-out of the reactor safety systems. In addition to the usual physical separation of redundant cable raceways, it was necessary to modify electric circuits in those areas where redundances could not be fully separated by fire boundaries. Examples of such changes in the logic circuits of the reactor protection system and the instrumentation of the reactor shut-down system are described.

56394 (INIS-mf—4470, pp vp) **Fracture of zircaloy cladding as a consequence of power increases in water reactor fuel rods.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56395 (INIS-mf—4470, pp vp) **Compatible small-scale yielding singular element and its application to LWR fuel rod analysis.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56396 (JAERI-M—7580) **Identification experiments in JPDR-II dynamics application of autoregressive modeling.** Kitamura, M.; Oguma, R.; Matsubara, K. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 55p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

A practical identification method has been studied experimentally for estimation of dynamics of nuclear power plants. In this method, time series data of process variables from a nuclear power plant are fitted to a multivariate autoregressive (AR) model. The optimal model parameters are determined by minimizing criterion Final Prediction Error (FPE) and solving the Yule-Walker equations. Pseudo-random binary sequences were applied to the JPDR-II plant of power 45MWt and 17 variables were observed. AR model fitting was made to the observed data for dynamic analysis. Feasibility of this method was confirmed by physically examining the identified dynamic response functions. Uncertain parameters in a theoretical dynamics model could be estimated successfully by comparing with the AR model obtained, indicating usefulness of the method.

56397 (JAERI-M—7624) **Mark II containment 1/6-scale pressure suppression test program: data report. I. (Pool swell tests: runs 106, 111, 114, 153, 160, 161, 162, 164, 165).** Kukita, Y.; Namatame, K.; Okazaki, M.; Shiba, M. (Japan Atomic Energy Research Inst., Tokyo). Apr 1978. 93p. (In Japanese). Dep. NTIS (US Sales Only), PC A06/MF A01.

The Mark II Containment 1/6-Scale Pressure Suppression Test Program of JAERI started in December 1976, sponsored by the Japanese BWR owners' group, to investigate the thermohydraulic response of a BWR Mark II pressure suppression system during a postulated loss-of-coolant accident with a 1/6-scale test facility. A total of 23 runs of pool swell and steam condensation tests were performed from January to June 1977 for the BWR owners' group, and after the termination of the contract, the test facility was transferred to JAERI. The present report provides a brief description of the test facility and instrumentation, test matrix and raw data from 9 runs of air-blowdown pool swell tests carried out from January to August 1977 as supplement to the runs performed under the contract. Qualitative interpretations of the data and plans for the future work are also presented.

56398 (KBS-TR—105) **Neutron induced activity in fuel element components.** Kjellbert, N. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Mar 1978. 30p. (In Swedish). (STUDSVIK-SM—78/4). Dep. NTIS (US Sales Only), PC A04/MF A01.

A thorough investigation of the importance of various nuclides in neutron-induced radioactivity from fuel element construction materials has been carried out for both BWR and PWR fuel assemblies. The calculations were performed with the ORIGEN computer code. The investigation was directed towards the final storage of the assembly components and special emphasis was put to the examination of the sources of carbon-14, cobalt-60, nickel-59, nickel-63 and zirconium-93/niobium-93m. It is demonstrated that the nuclides nickel-59, in Inconel and stainless steel, and zirconium-93/niobium-93m, in Zircaloy, are the ones which constitute the very long term radiotoxic hazard of the irradiated materials.

56399 **Development of a portable, high-energy radiographic source.** Reinhart, E.R.; Wenk, S.A.; Schonberg, R.G.; Mixon, G.L. *Mater. Eval.;* 37: No. 1, 37-42, 47(Jan 1979).

From American Society for Nondestructive Testing spring conference; New Orleans, LA, USA (3 Apr 1978).

The Electric Power Research Institute (EPRI) is sponsoring a two-year program to develop a portable, high-energy (3 to 4 MeV) radiographic system for inservice and repair inspections of components at nuclear power stations. The basic design concept uses a lightweight, portable linear accelerator (LINAC). The design objectives, concepts employed, and progress to date are described. Specific potential applications and accompanying radiographic techniques are discussed, along with the novel beam angulation devices to permit utilization in areas of highly restricted access.

56400 **Vibration measurements on a string of CANDU fuel bundles in adiabatic steamwater flow.** Forrest, C.F.; Monti, P.J.J. (Westinghouse Canada Ltd., Hamilton, Ontario. Atomic Power Div.). pp D3/12 1-9 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Flow induced vibration of fuel is an important consideration in the design and operation of vertical pressure tube reactors such as the CANDU-BLW (Canadian Deuterium Uranium - Boiling Light Water) reactor. Since the pressure tubes and fuel sheaths must maintain their integrity over the specified life of the component (30 years for the pressure tubes, 2 years for the fuel), fretting wear between these components must be kept to very low levels. Experimental data from tests on full scale components are required to verify the design and supply the many empiricisms required for analytical modelling of the system. The lateral vibrational velocity of the fuel string relative to the flow channel was measured at various axial locations with magnetic velocity transducers. These were attached to the channel opposite magnets embedded in outer elements of the fuel bundles. The signals from these transducers were analyzed to determine their spectral content and rms displacement.

56401 **Three-dimensional BWR suppression pool seismic sloshing analysis.** Lin, C.C.; Luk, C.H. (Stone and Webster Engineering Corp., Boston, MA (USA)). pp B5/4 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56402 **Transient response of structural components to unsteady flow impact and drag loads in a BWR suppression chamber.** Luk, C.H.; Hsieh, J.S. (Stone and Webster Engineering Corp., Boston, MA (USA)). pp B5/6 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56403 **Analaysis of steam vent clearing loads on the suppression pool.** Salmon, M.A. (Sargent and Lundy, Chicago, IL (USA)). pp B4/3 1-11 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The relief valve piping on a boiling water reactor vents steam to the suppression pool through a submerged discharge. The air in the piping trapped between the pool surface and the valve is injected into the pool on valve activation in the form of a high pressure bubble. This bubble induces pressures on the walls and bottom of the pool as it oscillates and rises to the surface. If compressibility effects are neglected and the bubble radius is assumed small the maximum and minimum pressures at the pool bounaries can be be found by the solution of the analoguous steady state heat conduction problem for the temperatures produced by a point source. A finite element solution for an axisymmetric pool with an assymetrically located

source is obtained as the sum of Fourier harmonics. The convergence of the solution is shown to depend on the pool radius and the proximity of the bubble to the boundaries. Analytical solutions are obtained for the horizontal and vertical force resultants and good agreement with the finite element solutions is demonstrated. Fluid structure interaction effects due to vertical rigid body motion of the pool are investigated by modeling the pool as a rigid spring supported tank in a rigid building with the building foundation modeled as a two degree of freedom mass spring system. The finite element method is shown to be suitable for the calculation of pressures and force resultants on the wall and botton of the suppression pool. The neglect of fluid structural interaction effects in calculting gross structural response is justified. However, it is shown that these effects can substantially reduce peak positive pressures and should therefore be accounted for in the interpretation of test results.

56404 Nuclear pressure boundary materials research problems and proposed solutions. Stahlkopf, K.E.; Smith, R.E.; Marston, T.U. (Electric Power Research Inst., Palo Alto, CA (USA)). pp G1/9 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The complete test discusses several important materials problems facing LWR operation and some of the research programs that have been formulated at EPRI to address these problems. The problems include steam generator corrosion damage, BWR pipe cracking, BWR nozzle corner cracking, and radiation induced embrittlement. LWR materials problems are complex and will not easily yield to solution. However, the economic rewards for the solution are great.

56405 PCPV for BWR: experimental investigations up to collapse of 1:10 scale model. Fumagalli, E.; Verdelli, G. (Istituto Sperimentale Modelli e Strutture (ISMES), Viale Giulio Cesare, Bergamo, Italy); Scotto, F.L. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp H4/5 1-9 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper deals with and outlines the problems and the solutions adopted for the modelling at 1:10 scale of a PCPV for a BWR station 1000 Mwel. that refers, as far as the internal dimensions are concerned, to the Scandinavian AB Atomenergi prototype and, as far as the PCPV structure is concerned, applies to the 'thin wall' ENEL concept and design philosophies. Namely, the paper refers to the phase B of the Italian ENEL-ISMES research; the phase A was the subject of the SMIRT-3 Paper H3/4. This B phase refers to the final integral solution (main structure plus removable LID) giving the most significant results of the tests carried out up to the collapse, and shows the typical solutions adopted to cope with the standard at very high modelling sophistications that was devised and pursued. In this B phase, side supporting tests have been carried out, up to the structural collapse, on two original solutions of removable prestressed concrete LID. The first, designed on the basis of the Dr. F.L. Scotto 'thin wall' philosophy, collapsed at 268 atm (collapse of hooping cable system). Therefore a less conservative 'very thin' solution has been tested. The structural collapse of this 'very thin' LID was reached at a pressure of 174 atm because of the collapse of the hooping cable system. The test carried out for the LID was performed in order to make a safe and ponderate choice of the LID to be applied to the final model of the PCPV.

56406 Finite element and physical model analysis of a removable lid of a P.C.P.V. for B.W.R. Riccioni, R.; Robutti, G.; Dal Bo, C. (Istituto Sperimentale Modelli e Strutture, Bergamo (Italy). Mathematical Model Department); Scotto, F.L. (ENEL, Centro Progettazione e Costruzione per gli Impianti Termici e Nucleari, Rome, Italy). pp H6/5 1-16 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A Prestressed Concrete Pressure Vessel for Boiling Water Reactor has been previously studied at ISMES (Experimental Institute for Models and Structures) Bergamo, Italy. The structure involved basically consists of a cylinder of constant thickness closed at the lower end with a bottom slab and at the upper end with a removable lid. Under working conditions the lid is anchored to the basic structure with a system of vertical cables as previously described: SMiRT-3 Papers H2/7, H3/4, H3/5. This report refers on studies carried out to analyse two new geometries of the removable lid, which differ from earlier ones in being thinner. The study was performed with a view to a twofold comparison: (1) Comparison between stress-strain behaviour as far as failure of the two solutions proposed by means of physical models, with reference to characteristic design parameters. (2) Comparison between results obtained through tests performed on a physical model and through calculations made with a finite element model.

56407 Axisymmetrical model for nozzle on cylindrical shell and comparison with experimental results. Tonarelli, L.C.; Azzola, M.D. (Nuclear Component Department, Breda Termomeccanica S.p.A., Viale Sarca, 336, I-20100 Milano, Italy). pp G8/3 1-8 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A method to compute, by means of an axisymmetrical model, the stresses in a nozzle on a cylindrical shell due to the internal pressure is presented. This model was developed starting from theoretical considerations and was then compared and adjusted using the results of the strain-gage measurements taken on the CAORSO boiling water reactor pressure vessel during the initial hydrotest. In particular, the steam outlet nozzle is examined here. In the stress analysis of a reactor pressure vessel and especially of a boiling water reactor, one of the largest jobs is the transient stress and fatigue analysis of the nozzles. In fact, there are several different types of nozzles on the cylindrical shell and for each one, many transients of temperature and pressure are usually specified. It results that many stress calculations on nozzles are necessary in the stress analysis of such a vessel. The size of the problem does not allow to use tridimensional programs due to the computer time they require. It becomes necessary, hence, to use a bidimensional model which can give satisfactory results. The two classical models are the nozzle-on-sphere and the nozzle-on-plate.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 56385, 56386, 56387, 56389, 56390, 56391, 56395, 56398, 56399, 56598, 56612, 56631, 56637, 56638, 56654, 56655, 56657, 56660, 56665, 56671, 56675, 56678, 56717, 56719, 56720, 56721, 56722, 56898

56408 (AED-Conf—78-011-000, pp 1-2) **Establishing and assessing refuelling plans for PWR reactors under the aspects of power distribution, cycle duration, and fuel costs.** Neubauer, W. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56409 (AED-Conf—78-011-000, pp 1-2) **Design for the use of plutonium in large PWR reactors.** Uyttendaele, P. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56410 (BMFT-FB-K—78-10) **Process computer program for the calculation of two dimensional power distributions in pressurized light water reactors.** Fite, J. (Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg (Germany, F.R.)). May 1978. 33p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

PROMED is a two-dimensional, two energy group burnup program which computes flux and power distribution performing a boron poison search or a calculation of ksub(eff) and the burnup distribution. At the beginning of a time step the program can, by option, insert a pre-determined rod configuration and perform a criticality search. This rod configuration can remain inserted during the time step or can be withdrawn. All these computations may be performed for a total, half, quarter or eighth reactor cross section. PROMED is written in FORTRAN IV for the Siemens '306' process computer system.

56411 (BMFT-FB-K—78-11) **Investigation of the cycle duration flexibility of pressurized lightwater reactors.** Bauer, F.; Kollmar, W. (Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg (Germany, F.R.)). May 1978. 61p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Regarding the cycle duration flexibility of pressurized water reactors, the - Adaptation of computer codes and test cases - Fuel element shuffling schemes after stretch-out operation - First core fuel arrangement - Economic investigations were investigated. The achieved results should enable power station operators to have a certain freedom in the choice of the fuel reloading time and to optimise an economical operation of their plants..

56412 (CAAP-TR—057) **Code assessment and applications program.** Ogden, D.M. (Idaho National Engineering Lab., Idaho Falls

(USA)). Sep 1979. Contract EY-76-C-07-1570. 62p. Dep. NTIS, PC A04/MF A01.

A RELAP4/MOD6 Blind Test Prediction of the FLECHT-SEASET Steam Generator Reference Test was made using actual boundary conditions from the test. The code options used were those that had given reasonable results in previous code assessment work with core simulations. Subsequent to the release of the remaining experimental data, further sensitivity calculations were performed. Conclusions concerning the blind prediction and the additional data comparison results are made with reference to the predictive capability of the code. This study was made as part of the INEL support to the NRC for Industry Cooperative Programs.

56413 (CEA-CONF—4191) **Experimental reactor Osiris and the nuclear fuel technology for the P.W.R. reactors.** Lestiboudois, G.; de Contenson, G.; Genthon, J.P.; Molvault, M.; Roche, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 1977. 15p. (In French). (CONF-771189—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Symposium on the future of research reactors; Grenoble, France (Nov 1977).

The possibility of employing research reactors to study and to improve the nuclear fuel of the power reactors is presented. Measurements of temperature, pressure, stresses, thermal balance, gamma spectrometry and neutron radiography, allow the study of fuel densification, the influence of the initial filling pressure on the fission gas release and the gadolinium efficiency evolution. The solutions of the problems of failed element detection, power increase, remote handling, are presented.

56414 (COO—4008-1) **PWR decontamination feasibility study.** Silliman, P.L. (Consolidated Edison Co. of New York, Inc., New York (USA)). 18 Dec 1978. Contract EY-76-C-02-4008. 233p. Dep. NTIS, PC A11/MF A01.

The decontamination work which has been accomplished is reviewed and it is concluded that it is worthwhile to investigate further four methods for decontamination for future demonstration. These are: dilute chemical; single stage strong chemical; redox processes; and redox/chemical in combination. Laboratory work is recommended to define the agents and processes for demonstration and to determine the effect of the solvents on PWR materials. The feasibility of Indian Point 1 for decontamination demonstrations is discussed, and it is shown that the system components of Indian Point 1 are well suited for use in demonstrations.

56415 (IAE—2781) **Technique for WWER-type reactor fuel element cluster power calculation in the two-group diffusion approximation.** Marakazov, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 28p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The technique for the two-group diffusion problem solution in the region consisting of rectilinear hexahedral prisms with different group cross sections is given. The technique is realized in the BIPR-6 programm, using the coarse pitch of the difference grid (one point on the prism-cassette in the view) and intended for WWER-type reactor physical calculations. Using characteristic methodical examples for the WWER-reactors it is shown that the BIPR-6 programm permits to obtain the problem solution with an error less than 1% for the values of the average cassete energy release.

56416 (IAE—2943) **Neutron importance calculation in an equivalent cell using the age approximation and differential thermalization models. Determination of the cross section sensitivity to the parameters of a differential model in the thermal range.** Sidorenko, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. 40p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The equations are discussed for calculating the importance of neutron function in heterogeneous media obtained with the integral transport theory method. The thermalization effect in the thermal range is described using the differential model. The account of neutron slowing-down in the epithermal range is accomplished in the age approximation. The fast range is described in the 3-group approximation. On the basis of the equations derived the share of delayed neutrons and lifetimes of prompt neutrons are calculated and compared with available experimental data. In the thermal range the sensitivity of cross sections to some parameters of the differential model is analyzed for reactor cells typical for WWER type reactor cores. The models and approximations used are found to be adequate for the calculations.

56417 (INIS-mf—4240) **Qualification of electrical equipment. A United States nuclear system supplier perspective.** Jordan, W.G. (Westinghouse Electric Corp., Pittsburgh, PA (USA). PWR Systems Div.). 1978. 17p. (CONF-7710184—12). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

At Westinghouse Pressurized Water Reactor Systems Division (PWR-SD) qualification of safety related electrical equipment can be segregated into three distinct generations: (1) the initial seismic and environmental qualification programs for electrical equipment (1969-1972); (2) the supplemental sismic and environmental qualification programs (1975-1977); and (3) the seismic and environmental qualification programs to meet IEEE-323-1974, IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"(1975). The latter two programs (in a licensing framework), as they are most current, with emphasis on electrical equipment (e.g. transmitters, rack mounted equipment) as opposed to electro-mechanical equipment (valve operators, pump motors) are reviewed.

56418 (INIS-mf—4470, pp vp) **Sensitivity of fuel performance code analysis to design and property assumption.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The code COMETHE III-J was used to demonstrate the sensitivity of fuel performance codes to input properties, assumed models and small changes in design parameters. For this study the Maine Yankee Core 1 rods were chosen, because of the unexpected phenomenon which was observed during a very complete PIE of these rods. The examination showed, that a group of almost identical rods, which underwent similar power history could be separated into two populations of fractional gas release (less than 1% and 11.3 to 13.5%). Low gas release rods showed no fuel restructuring whereas the high gas release rods showed equiaxed grain growth in the fuel along almost the total fuel column. The rods with extended equiaxed grain growth and the high fractional fission gas release rates could be simulated by the COMETHE code, using the actual power history and fuel pin design data. The fuel centerline temperature of this case showed the unexpected trends. Axial segments with lower axial peaking factors showed higher central fuel temperatures than segments with higher axial peaking factors for end of like condition. The reversed trends of the fuel centerline temperatures were caused by a combination of gap closure, fission gas release behavior and relocation due to fission gas bubble swelling. A parametric study was performed for this case to study the sensitivity of the code. Specifically the following variables were examined: fuel pin power level, amount of fuel densification, as fabricated gap, cladding creep rates, initial pressurization level, amount of sorbed gases, clad thickness, relocation model.

56419 (INIS-mf—4470, pp vp) **Thermal creep of zircaloy-4 cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Zircaloy-4 is widely used as the cladding material in pressurized water reactors, and a knowledge of creep characteristics of zircaloy-4 fuel cladding is essential in reliably predicting fuel rod performance. Data on the hoop creep characteristics of zircaloy tubing were collected at temperatures between 600F and 800F, and at stress levels ranging from 10 ksi to 25 ksi using internal pressurization tests. At low driving forces, exposures as long as 2000 hours were found insufficient to establish steady state creep. The experimental data at temperatures of 650F to 800F correlate well with an exponential stress dependence, and the activation energy for creep was found to be in excellent agreement with that for self-diffusion. The range of stresses and temperatures is too small to study the overall effect of these variables on the activation energy for creep. The transient creep regime was analyzed on the premise that primary creep is directly related to the rate of dispersal of dislocation entranglements by climb. In correlating the primary creep behavior at the temperatures and stress levels used, a plot of creep strain versus epsilon st indicated that data at different temperatures and stresses fall on a universal creep curve. An Avrami-type equation is shown to be a good first approximation in describing the universal curve. The fundamental difference between this formulation and the more familiar Andrade's tsup(1/3) law is that the initial creep rate (at t=0) is regarded finite here.

56420 (INIS-mf—4470, pp vp) **Validation of in-pile creep-collapse analysis of zircaloy cladding by direct experiments.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In-pile creep-collapse experiments were performed with zircaloy-4 cladding and two different methods of analysis are used. The first one is a semi-empirical method based on the use of tangent or reduced modulus and isochronous curves. In this case the clad is assumed to remain perfectly round and collapse occurs when the modulus reaches a critical value. The calculation gives the critical time of creep-buckling. The second is an analytical method, where the clad is treated as a thin shell and its ovalisation resolved into a trigonometric series the factors of which are time dependent. The in pile creep collapse experiments were performed with clads from different batches of zircaloy-4. These batches are obtained from the same material (zircaloy-4 with high oxygen and tin content), but different final annealing temperature: 2 hours at 490°C, 525°C or

575°C. For each of these batches a complete formulation of in-pile diametral creep was obtained from in-pile experiments on end-closed tubes under internal pressure. These expressions describe the primary and secondary stages of the in-pile creep in a temperature range from 330 to 385°C, for fluxes (>1MeV) from 0.5 to 2.10^{14} n/cm^{2}s and hoop stresses between 4 and 13 kg/mm^2. For the high stress cases, these expressions were completed by use of the Nichols model, ensuring the continuity of the secondary creep rates. The present survey consists in proposing, for each of the two calculation methods, the adjustment required to give a good agreement between the calculations and the experiments.

56421 (KFKI—1977-109) **Experimental high pressure water loop Pt. 2. Instrumentation and data acquisition.** Szabados, L.; Beszeda, T.; Csom, V.; Maroti, L.; Windberg, P. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Jan 1978. 37p. (In Hungarian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The data acquisition system of a high pressure water loop built for the investigation of thermohydraulic processes in water-cooled nuclear power reactors is described. The most common types and the characteristics of the sensors in use for the large experimental program as well as the layout of the different measuring lines and their connection to the data acquisition system are presented. Finally a summary of the main characteristics of the data acquisition system is given and a test section of the loop is described in detail.

56422 (NUREG/CR—0130(Add.)) **Technology, safety and costs of decommissioning a reference pressurized water reactor power station.** Smith, R.I.; Polentz, L.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 168p. Dep. NTIS, PC A08/MF A01.

Additional analyses of decommissioning of the reference pressurized water reactor (PWR) power station are made that examine some parameters not covered in the initial study report (NUREG/CR-0130). The parameters examined are: (1) the effect of plant size on costs and radiation exposure for dismantlement, (2) the costs and radiaton exposures associated with entombment of the reference PWR, (3) the impact on costs and radiation exposure of higher radiation dose rates throughout the facility than were assumed in the initial study, (4) the effect on costs of using individual contractors to accomplish dismantlement rather than using the utility staff as postulated in the initial study, and (5) the effect on costs of increasing disposal charges at waste disposal facilities.

56423 (NUREG/CR—0718) **Steam generator tube integrity program. Phase I report.** Alzheimer, J.M.; Clark, R.A.; Morris, C.J.; Vagins, M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 271p. (PNL—2937). Dep. NTIS, PC A12/MF A01.

The results are presented of the pressure tests performed as part of Phase I of the Steam Generator Tube Integrity (SGTI) program at Battelle Pacific Northwest Laboratory. These tests were performed to establish margin-to-failure predictions for mechanically defected Pressurized Water Reactor (PWR) steam generator tubing under operating and accident conditions. Defect geometries tested were selected because they simulate known or expected defects in PWR steam generators. These defect geometries are Electric Discharge Machining (EDM) slots, elliptical wastage, elliptical wastage plus through-wall slot, uniform thinning, denting, denting plus uniform thinning, and denting plus elliptical wastage. All defects were placed in tubing representative of that currently used in PWR steam generators.

56424 (VEIKI—15.97-025-2) **Investigation of flow induced vibrations.** Siklossy, P. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). Jun 1978. 76p. (In Hungarian). Library of Institute for Electrical Power Research, 1368 Budapest, P.O.B. 233, Hungary.

The behaviour of structural elements of nuclear power plants with PWR type reactors has been investigated, considering the pressure fluctuation of circulating cooling water as generating force. Causes of structural element vibrations have been analyzed, and methods of measurements and of measured data evaluation have been treated. Experiences gained by vibration measurements carried out in different power plants in other countries have been presented. A proposal has been made for measurements in the primary cooling circuits of Paks Atomic Station during installation and normal operation to make the vibration state analysis of structural elements possible.

56425 (VEIKI—15.98-035-2) **Measurements on main equipments and auxiliary systems of primary coolant loops.** Voross, L. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). Jun 1978. 55p. (In Hungarian). Library of Institute for Electrical Power Research, 1368 Budapest, P.O.B. 233, Hungary.

Proposals have been made for investigations to be carried out in primary coolant loops of nuclear power plants. Conditions of available commissioning and special measurements have been treated with respect to primary sensors. The proposal includes the analysis of leakage rate in hermetical rooms, measurement of reactor thermal power, problems of surface temperature and extension measurements, task of heating up and reconnection of a closed and disconnected coolant loop. Specifications of necessary sensors are given, topics of signal processing and accuracy are mentioned.

56426 **Vibrational characteristics and wear of fuel rods.** Schmugar, K.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Water Reactor Divisions). pp D3/9 1-18 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Fuel rod wear, due to vibration, is a continuing concern in the design of liquid cooled reactors. In this report, the methodology and models that are used to predict fuel rod vibrational response and vibratory wear, in a light water reactor environment, are discussed. This methodology, is being followed at present in the design of Westinghouse Nuclear Fuel. It is difficult to develop reliable design methods for predicting fuel rod wear because: 1. The dynamic characteristics of the fuel rod assembly are complex. 2. The basic excitation mechanisms causing fuel rod vibration require complete characterization. 3. The parameters that determine the wear between materials must be established. Fuel rod vibrations are expressed as the normal bending modes, and sources of rod vibration are examined with special emphasis on flow-induced mechanisms in the stable flow region.

56427 **Finite element creep analysis of PCRV and comparison with experimental results.** Shioya, S. (Nihon Univ., Tokyo); Kawamata, S. (Tohoku Institute of Technology, Sendai-shi, Japan); Tanaka, N. (Shimizu Construction Co. Ltd., Tokyo (Japan). Research Lab.). pp H4/6 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56428 **Research programme sponsored by CEA concerning the failure probability calculation of a PWR vessel.** Dufresne, J.; Carnino, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire); Quero, J.; Grandemange, J. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)); Volta, G.; Elbaz, J. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp G6/6 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 56387, 56609, 56640, 56667, 56672, 56673, 56724

56429 (AED-Conf—77-528-001) **Advancement of the HTR line.** Hirschfelder, G. (Vereinigte Elektrizitaetswerke Westfalen A.G. (VEW), Dortmund (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 13p. (In German). (CONF-7703115—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting on kraftwork Schmehausen; Schmehausen, F.R. Germany (23 Mar 1977).

The article lists the achievements so far in the field of HTR reactors. The advantages of this reactor line are described, and the problems encountered in its commercial introduction are pointed out.

56430 (AED-Conf—78-011-000, pp 1-2) **Comparing economically optimum designs of the HTR fuel cycle.** Schmid, U.A.; Brandes, S.; Dietl, G. (Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56431 (CEA-CONF—4193) **Studies on high temperature reactors at Osiris experimental reactor.** Loriers, H.; Ballagny, A.; Genthon, J.P.; Micaud, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 1977. 21p. (In French). (CONF-771189—3). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Symposium on the future of research reactors; Grenoble, France (Nov 1977).

For the study of the HTGR core materials it is necessary to have irradiation facilities with temperatures between 300 and 1400°C

and graphite fluence damage reaching 12 10^{21}n.cm^{-2}. Neutron fluxes in experimental locations of the Osiris reactor are 6.3 10^{14}n.cm^{-2}s^{-1} max in the same damage unit and it is possible to obtain these doses in a reasonable length of time. The gamma fluxes in these places allow the construction of devices without added electric heating and so there are more reliable in time.

56432 (GA-A—15141) **Influences of the couple-stresses on the pure-bending of a circular cylinder.** Kao, B.G.; Tzung, F.K.; Ho, F.H. (General Atomic Co., San Diego, CA (USA)). Jul 1979. Contract EY-76-C-03-0167-065. 47p. Dep. NTIS, PC A03/MF A01.

This report presents the solution to the pure-bending of a circular cylinder with the couple-stress theory of linear elasticity. A linear bending moment-curvature relation is derived parallel to the classical beam theory. The section modulus (or the proportional coefficient) associated with the couple-stress theory is always greater than that predicted by the classical theory, and the ratio of the former to the latter increases as the radius of the beam decreases. These aspects clearly agree with the observed behavior of nuclear-grade graphite. Based on the solution, it is further estimated that the characteristic length l_2 of the couple-stress theory for H-451 graphite ranges from 0.62 to 1.54 mm. This range of l_2 concurs with the magnitude of the grain size (maximum is 1.57 mm for H-451 graphite) and agrees with an aspect of the couple-stress theory.

56433 (IEA-DT—065) **Preliminary definition of the parameters of an experimental natural - uranium, graphite - moderated, helium - cooled power reactor.** Baltazar, O. (Instituto de Energia Atomica, Sao Paulo (Brazil); Sao Paulo Univ. (Brazil). Escola Politecnica). Jul 1978. 160p. (In Portuguese). Dep. NTIS (US Sales Only), PC A09/MF A01.

Thesis.

A preliminary study of the technical characteristic of an experiment at 32 MWe power with a natural uranium, graphite-moderated, helium cooled reactor is described. The national participation and the use of reactor as an instrument for the technological development of future high temperature gas cooled reactor is considered in the choice of the reactor type. Considerations about nuclear power plants components based in extensive bibliography about similar English GCR reactor is presented. The main thermal, neutronic an static characteristic and in core management of the nuclear fuel is stablished. A simplified scheme of the secondary system and its thermodynamic performance is determined. A scheme of parameters calculation of the reactor type is defined based in the present capacity of calculation developed by Coordenadoria de Engenharia Nuclear and Centro de Processamento de Dados, IEA, Brazil.

56434 (INIS-mf—4470, pp vp) **Influence of the statistical scatter of both the geometry parameters and the coating strength on the failure rate of coated fuel particles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The study was performed for particles with a SiC interlayer. Here the whole fission gas pressure acts on the SiC as its Young's modulus is about ten times higher than that of the two dense PyC layers. This stress is reduced by the irradiation induced shrinkage and creep of the two dense PyC layers. It can be determined with stress model calculations taking into account the mechanisms mentioned above. It is assumed that the particle fails when the SiC breaks. Calculations show that the influence of the outer coating layer thicknesses on the SiC stress is far below that of the kernel diameter and buffer thickness. The kernel diameter and buffer thickness have a scatter which is determined by the fabrication process, for this scatter a Gaussian distribution was assumed, the mean values and standard deviations were measured. The SiC strength shows an additional material inherent scatter for which a Weibull distribution was assumed. Its mean value and Weibull parameter were measured. It can be shown that the influence of the scatter in the geometry parameters on the mean value of the SiC strength may be neglected. Stress model calculations were performed systematically for various buffer thickness and kernel diameter combinations at different burn-ups. Using the calculated stresses and the distributions of these two parameters it is possible to calculate the stress distributions over the particles at the corresponding burn-ups. Taking into account the strength distribution of the SiC, the fraction of particles expected to break was then determined as a functio.

56435 (INIS-mf—4470, pp vp) **Transient irradiation behavior of HTGR fuel particles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An examination of HTGR TRISO coated fuel particles was made in which the particles' stress-strain histories were determined during both steady-state and transient operating conditions. The basis for the examination was a modified version of a computer code written by Kaae which assumed spherical symmetry, isotropic thermal expansion, isotropic elastic constants, time-temperature-irradiation invariant materials properties, and steady state operation during particle exposure. Additionally, the Kaae code modelled potential separation of layers at the SiC-inner PyC interface and considered that several entrapped fission products could exist in either the gaseous or solid state, dependent upon particle operating conditions. Using the modified code which modelled transient behavior in a quasi-static fashion, a series of both steady-state and transient operating condition computer simulations was made. For the former set of runs, a candidate set of particle dimensions and a nominal set of materials' properties was assumed. Layer thicknesses were assumed to be normally distributed about the nominal thickenesses and a probability distribution of SiC tensile stresses was generated; sensitivity of the stress distribution to assumed standard deviation of the layer thicknesses was acute. Further, this series of steady-state runs demonstrated that for certain combinations of the assumed PyC-SiC bond interface strength and irradiation-induced creep constant, anomalous predicted stresses may be obtained in the PyC layers. The steady-state runs also suggest that transient behavior would most likely not be significant at fast neutron exposures below about 10^{21} NVT due to both low fission gas pressure and likely beneficial interface separation.

56436 (JAERI-M—7565) **Studies on a thermal insulation layer in the high pressure, high temperature gas. I. Discussions of the natural convective heat transfer in the thermal insulation layers and experimental apparatus.** Shimomura, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 78p. (In Japanese). Dep. NTIS (US Sales Only), PC A05/MF A01.

Basic equations of heat transfer in a thermal insulation layers are presented in the high pressure, high temperature gas atmosphere. Natural convective heat transfer in the packed beds is then studied. Further described are experiments plans and principal particulars of experimental apparatus based on the above discussions.

56437 (JAERI-M—7566) **Studies on a thermal insulation layer in the high pressure, high temperature gas. II. Heat transfer analysis in the horizontal annular insulation layer.** Shimomura, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 29p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Thermal insulation problems in HTGR technology and natural convective heat transfer in a horizontal annular thermal insulation layer important in VHTR piping are studied. The product of Rayleigh number Ra and Darcy number Da, (RaDa) and the ratio of outer and inner radii of the annular layer (r sub(o)/r sub(i)) are governing parameters of the mean heat transfer characteristics. From numerical analysis, the relative increase of mean effective thermal conductivity (lambda sub(e)/lambda) is formulated as: (lambda sub(e)/lambda) sub(m) = 0.168 (r sub(o)/r sub(i) - 0.924)sup(1/2), 1.25 <= r sub(o)/r sub(i) <= 3, (lambda sub(e)/lambda) >= 1. In the region of (lambda sub(e)/lambda) sub(m) >= 1, the amplitude of local heat flux and the effective conductivity at inner and outer boundaries increase notably with increase of the product of Rayleigh number and Darcy number RaDa. Therefore, thermal design of the annular insulation with conduction model will be insufficient.

56438 (JAERI-M—7638) **Guidelines for inservice inspection of component in experimental multi-purpose very high temperature gas-cooled reactor plant.** Ooka, K.; Muraoka, S.; Ezaki, M.; Kodaira, T. (Japan Atomic Energy Research Inst., Tokyo). May 1978. 108p. (In Japanese). Dep. NTIS (US Sales Only), PC A06/MF A01.

The guidelines for structural design of experimental multi-purpose very high temperature gas-cooled reactor (EX-VHTGR) specify the guidelines for quality assurance of materials and welds during fabrication and construction, and inservice inspection to obtain integrity of the structures. The guidelines for inservice inspection are presented, which considers Nuclear Safety Criteria for the Design of Stationary Gas Cooled Reactor Plants, Guidelines for the Structural design of EX-VHTGR at Elevated Temperature Service, ASME Boiler and Pressure Vessel code sec. XI, specifications of EX-VHTGR's system construction. Covered are inspection intervals, areas for examination, extents of examination, examination methodes, examination results evaluation, etc. in three classes of components according to safety nature.

56439 (JAERI-M—7727) **One stacked-column vibration test and analysis for VHTR core.** Ikushima, T.; Ishizuka, H.; Ide, A.; Hayakawa, H.; Shingai, K. (Japan Atomic Energy Research Inst., Tokyo). Jul 1978. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This paper describes experimental results of the vibration test on a single stacked-column and compares them with the analytical results. A 1/2 scale model of the core element of a very high temperature gas-cooled reactor (VHTR) was set on a shaking table. Sinusoidal waves, response time history waves, beat wave and step wave of input acceleration 100 - 900 gal in the frequency of 0.5 to 15 Hz were used to vibrate the table horizontally. Results are as follows: (1) The column has a non-linear resonance and exhibits a hysteresis response with jump points. (2) The column vibration characteristics is similar to that of the finite beams connected with non-linear soft spring. (3) The column resonance frequency de-

creases with increasing input acceleration. (4) The impact force increases with increasing input acceleration and boundary gap width. (5) Good correlation in vibration behavior of the stacked-column and impact force on the boundary between test and analysis was obtained.

56440 (Juel—1528) **NAKOGAS-1, a computer code for the evaluation of transient temperature- and flow distributions in pebble-bed-reactors after failure of forced coolant flow.** Hoefer, I.; Klumpp, W.; Badur, A.; Finken, R.; Meister, G.; Rehm, W. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung). Aug 1978. 58p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The code NAKOGAS-1 has been developed for the evaluation of the thermodynamic behaviour of pebble bed reactors in the case of failure of forced cooling. It is preferently designed for evaluation of flow and temperature fields which may aise under natural convection conditions but it is also suited for natural convection with superimposed forced convection. The code models the reactor core and the surrounding structure two-dimensional in cylindrical geometry. In addition those components of the primary circuit which may influence the gas convection are included. The pebble bed is modelled as a quasi homogenous 2-phase medium with energetic coupling between both phases. Energy transfer by conduction, convection and radiation is taken into account. The presented report contains a description of the mathematical model underlying the programme and of the numerical method being used. The code structure is described and results of a typical sample case are illustrated.

56441 (Juel—1529) **Influence of high axial pressure gradients on the behaviour of the kohlestein insulation.** Broeckerhoff, P. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Aug 1978. 49p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

It was the aim of this research to test the efficiency of the sealings subjected to high velocities or high axial pressure gradients. Furthermore it should be tested if the pressure gradients cause an additional heat transport through the pores of the material. The experiments have been carried out in the high pressure wind tunnel at pressures up to about 40 bars. To get high velocities a displacement body has been mounted. Maximum velocities of about 62 m/s and 45 m/s could be reached using helium or air, respectively. Helium temperatures of about 400°C were achieved. The maximum air temperatures were restricted to 300°C because of the corrosion of the kohlestein. After sealing the gaps the temperature distribution along and around the insulation was uniform. The temperature peaks observed at the fourth ring are the consquence of a recent crack. The thermal fluxes are independent of the pressure except at the highest velocity. They are lower than those of the previous tests. Furthermore the distribution of the fluxes is nearly uniform.

56442 **Fluctuating pressure forces acting on the hot gas duct of a high temperature reactor.** Achenbach, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). pp B3/9 1-10 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the hot gas ducts of high temperature reactors high velocities ($70<u<200$m/s) occur. As at the same time the primary circuit is pressurized ($40<p<60$bar) the dynamic pressure forces have a high intensity. The fluctuating forces act on the thermal insulation of the ducts and may cause damages during the time of operation. The aim of the present work is to measure the intensity of the fluctuating pressure generated in several differently shaped bends of the ducts according to its level and frequency. On the basis of the model tests, the results of which are fed into the theory, prediction can be made of the exciting forces acting on a HTR hot gas duct under operation. The dynamic pressure forces are caused by the velocity fluctuations of the flow. These fluctuations can have its origin either from the turbulent motion or from separation phenomena of the flow. As it is well known flow separation occurs in bends and produces large eddies travelling downstream and generating pressure fluctations. In the model tests four types of bends have been examined: circular bends of circular cross section 90°-bends of segmental design; 90°-bends, mitred; 90°-mitred, rectangular channel. For comparison the pressure fluctuations of the straight tube were also determined. The experiments were conducted in air, pressurized air and helium. The pressure fluctuations were measured by means of condenser microphones.

56443 (ORNL/TM—6819) **Characterization of pyrocarbon coatings of HTGR fuel particles by inert gas intrusion.** Morgan, C.S. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

Biso fuel particles used in the HTGR have a pyrocarbon coating designed to retain fission gases during reactor operation. The inert gas permeability of the pyrocarbon coating is variable and a measure of it is an important clue to fuel performance. A method was developed to measure the permeability of pyrocarbon coatings by intrusion of light inert gases. The mole quantity of neon and helium entering the fuel particle at elevated temperature (1375°C for 1 h) from an equimolar mixture is determined by mass spectrometry after breaking the particle. The ratio of the two gases constitutes a useful measure of the pyrocarbon coating permeability. Activation energies for intrusion of helium, neon, and argon show a sharp increase with atomic number. Pyrocarbon coatings have a measurable permeability for krypton only at very high temperatures and only then in the more permeable coatings. Neutron irradiation reduced the permeability of the pyrocarbon coatings on inert kernels. Neon and helium ratios measured on hundreds of fuel particle batches ranged from 0.03 to greater than 1.0, and we estimate that a pyrocarbon with neon-helium ratio below 0.30 or 0.35 will be gastight under HTGR operating conditions.

56444 (STUDSVIK-BL—78-3) **Fission product migration in intact fuel rods. S176 experiments 1-5: Gamma spectrometric and beta autoradiography results on radial fission product distribution.** Blackadder, W.; Forsyth, R.; Malen, K.; Nilsson, Bengt-Aake. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Mar 1978. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This report is the third of a group which present the results obtained during the first 5 experiments in the S176 series of irradiation experiments. The aim of this series is to provide information on the distribution of fission products in intact irradiated fuel rods, both within the UO_2, fuel and on the inside of the Zircaloy clad. Fuel rods, previously irradiated to appreciable burnups in the Aagesta R3 reactor, after cooling, are reirradiated in the Studsvik R2 test reactor for short periods to build up significant inventories of short-lived fission products of interest. The irradiation conditions are well defined. Examination of sections of fuel and clad within a short time after removal from the reactor is performed by means of high-resolution Ge(Li) gamma spectrometry. The fuel sections are also examined metallographically to determine fuel structure, and by β autoradiography.

56445 (STUDSVIK-RA—78-2) **High Temperature reactors status 1977.** Ekholm, R.; Bosaeus, J.; Carleson, G.; Gelin, R.; Jirlow, K.; Linder, S.; Menon, S.; Runfors, U.; Vieider, G. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Mar 1978. 390p. Dep. NTIS (US Sales Only), PC A18/MF A01.

The objective of this report is to summarize the current state-of-the-art of HTR technology as part of follow-up studies of the development of advanced fission reactor systems. These studies have been performed at AB Atomenergi since fiscal year 1975/76 and are financed by governmental funds for energy R and D. In this report emphasis is given to the following main aspects of the HTR development: - a survey of the major HTR - R and D programmes; - the description of HTR technology including remaining development problems and uncertainties; - the analysis of the safety and environmental characteristics of the HTR systems; - the analysis of the incentives for the introduction of various HTR types. The report contains also information kindly provided directly by experts from several organisations developing the HTR-systems.

56446 **Contribution to fracture criteria for graphite.** Cords, H.; Kleist, G.; Moench, J.; Schuster, H.; Zimmermann, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). pp D5/6 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The calculation of stresses and strains in graphite core components of the high temperature reactor is generally performed using the rules of linear elasticity. In this paper two alternative methods to solve the problem of failure of graphite components are proposed: (1) The most reliabe test of fracture strength of a component is clearly the mechanical loading of a true replica of the component under conditions simulating the service conditions. However, such experiments are prohibitively expensive and, therefore, the strengths of the components are generally compared with those of classical specimen types viz. tensile, bend, torsion or compact (CT) specimen. It is proposed to use test specimens whose shapes and stress distributions are nearly the same as those of the components in regions where peak stresses are found. The two similar stress distributions are fitted to each other by means of a linear least squares fit. (2) The second procedure to evaluate fracture strengths is a new fracture criterion based on a linear elastic calculation of the energy density proportional constant k^2, averaged over an element of volume ΔV. The quantities $Ksub(i)^2$ related to different parts of the component are then weighted according to the Weibull statistics and summed over the total volume of the component V to yield a risk value.

56447 **Studies on the graphite rupture under secondary stresses.** Gros, G.; Ballagny, A.; Jonquet, G.; Sejourne, S. (CEA Centre

d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). pp D5/7 1-11 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In HTGR graphite fuel elements, stresses are mainly induced by temperature distributions which cause differential thermal and irradiation strains. In order to verify the adequacy of the fuel element design, it is necessary to compare the calculated stresses with the measured mechanical resistance of the material. A test program has been set up at CEA where two types of experiments are performed: 1. Rupture of graphite tubes under thermal gradient and 2. Rupture of graphite bodies under irradiation. The results of the detailed calculations are presented in the paper. All the stress calculations are performed with the PASTEL program of the CEA-SEMT system of structures analysis.

56448 Residual stresses in Peach Bottom test elements analysis vs experiment. Homeyer, W.G.; Tzung, F.K.; Chiang, D.D. (General Atomic Co., San Diego, CA (USA)). pp D5/4 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Operating stresses and residual shutdown stresses in fuel elements irradiated in the Peach Bottom Reactor were calculated with finite element methods. Calculations of deformation and stress due to primary loads were also made. Results of the calculations were used to develop an experimental analysis of graphite fuel and reactor elemnts. Measured deflections and fracture loads were then compared with predictions made with the analytical methods and data to be verified.

56449 Transient irradiation behavior of HTGR fuel particles. Mortenson, S.C.; Okrent, D. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). pp C1/6 1-7 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An examination of HTGR TRISO coated fuel particles was made in which the particles' stress-strain histories were determined during both steady-state and transient operating conditions. The basis for the examination was a modified version of a computer code written by Kaae which assumed spherical symmetry, isotropic thermal expansion, isotropic elastic constants, time-temperature-irradiation invariant materials properties, and steady state operation during particle exposure. Additionally, the Kaae code modelled potential separation of layers at the SiC-inner PyC interface and considered that several entrapped fission products could exist in either the gaseous or solid state, dependent upon particle operating conditions. The Kaae code was modified to study the effects of each of the following in the prediction of layer stresses: (1) changes in Young's modulus of elasticity for both PyC and SiC with fluence and/or temperature; (2) temperature dependence of the internal fission gas pressure calculations; (3) a second-order correction to the residual thermal stress calculation; (4) sensitivities of the stresses to phenomena modelled.

56450 Isolation and analysis of critical stress areas in graphite fuel elements. Smith, P.D.; Tang, P.Y. (General Atomic Co., San Diego, CA (USA)). pp D5/2 1-11 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a summary of methods being used at General Atomic for the analysis of irradiation-induced stresses in the graphite fuel elements of a high-temperature gas-cooled reactor (HTGR). This is a computationally demanding problem for three reasons: (1) The graphite material response is nonlinear and time-dependent. (2) There are thousands of fuel elements in the core, all having different load histories. (3) The geometry and the stress fields of the elements are complicated. This problem has been solved by developing a hierarchy of four related visco-elastic computer programs. These employ a consistent set of physical approximations ranging from one-dimensional beam theory to three-dimensional continuun theory. Some of the physical models have not been previously reported, and the paper describes the novel and useful features of these models. The main topic of the paper is a systematic strategy for the isolation and detailed analysis of critical stress areas.

56451 Rules for design of nuclear graphite core components - some considerations and approaches. Svalbonas, V.; Stilwell, T.C.; Zudans, Z. (Franklin Inst. Research Labs., Philadelphia, PA (USA)). pp D5/1 1-13 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the High Temperature Gas reactor (HTGR) core a large number of elements are constructed of nuclear graphite. This paper discusses the attendant difficulties, and presents some approaches, for ASME code safety-consistent design and analysis. The statistical scatter of material properties, which complicates even the definitions of allowable stress, as well as the brittle, anisotropic, inhomogeneous nature of the graphite was considered. It was found that analytic statistical methods used to arrive at a definition of minimum ultimate strength were totally unrealistic It was concluded on the basis of presently available evidence that the distinctions between secondary and primary stresses are inappropriate to graphite structures. The proposed overall design criteria and stress limits for graphite structure were reviewed. The use of the homologous stress concept is graphite fatigue calculations was reviewed. The overall design philosophy for brittle materials is applied to HTGR core structure design including such areas as graphite oxidation, component proof tests, experimental seismic modeling and fracture analysis.

56452 Residual stress and strain examination in Peach Bottom fuel test elements. Wallroth, C.F.; Miller, C.M.; Saurwein, J.J. (General Atomic Co., San Diego, CA (USA)). pp D5/3 1-13 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An examination of residual stresses and strains has been carried out experimentally on structural graphite compounds removed from the Peach Bottom high temperatures gas cooled reactor (HTGR) fuel elements. The purpose is to confirm predicted stress distributions.

56453 New experiences with partial prestressing of PCRV based on large model tests. Schimmelpfennig, K.; Schnellenbach, G. (Consulting Engineers Prof. Zerna-Dr. Schnellenbach, Viktoriastrasse, Bochum, Germany, F.R.). pp H4/4 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56454 Design, fabrication and erection of liner for prestressed concrete pressure vessel in 300 MWe THTR nuclear power plant. Albrecht, W. (Steinmueller (L.u.C.) G.m.b.H., Gummersbach (Germany, F.R.)). pp H6/1 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56455 Research and development program for prestressed cast iron pressure vessels (PCIV) for high temperature reactors. Beine, B. (Siempelkamp Giesserei K.G., Krefeld (Germany, F.R.)). pp H1/7 1-8 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Based on the Siempelkamp activities in the field of the development of prestressed cast iron pressure vessels, a cooperation contract concerning the development of the Prestressed Cast Iron Pressure Vessel (PCIV) for high temperature reactors (HTR) has been signed between: Gesellschaft fuer Hochtemperatur Reaktortechnik mbH (GHT), Hochtemperatur Reaktorbau GmbH (HRB), Steinmueller, and Siempelkamp. The research and development program for this type of PCIV is sponsored by the Ministry for Economics and Transportation of the state of Northrhine-Westphalia. The objects of the R and D program are: - Fully worked out construction plans. - Demonstration of the decisive economic advantages of this new type of vessel. - Plans designed to meet the requirements of licenzing authorities. - A preliminary safety report.

56456 Acoustic environment in large HTGRs. Burton, T.E. (General Atomic Co., San Diego, CA (USA)). pp B3/7 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56457 Design, analysis and construction of the hot-working cast iron pressure vessel (PCIV). Hentschke, W.; Ostendorf, H. (Siempelkamp Giesserei K.G., Krefeld (Germany, F.R.)). pp H1/10 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56458 Design concept for a prestressed cast-iron pressure vessel with hot walls for gas-cooled high-temperature reactors. Schwiers, H.G.; Schoening, J. (Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (Germany, F.R.)); Beine, B. (Siempelkamp Giesserei K.G., Krefeld (Germany, F.R.)). pp H1/6 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56459 Design, analysis and construction of the liner for hot-working prestressed cast iron pressure vessels (PCIV). Vogt, H.J.; Weber, R. (Steinmueller (L.u.C.) G.m.b.H., Gummersbach (Germany, F.R.)). pp H1/8 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 56385, 56387, 56394, 56709

56460 (AEEW-R—1197) **Systematic method for correlating measurements of channel powers with the lattice constants in the neutron diffusion equations.** Buckler, A.N. (UKAEA, Winfrith. Atomic Energy Establishment). Oct 1978. 52p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The report describes the theoretical basis of the methods that have been developed for correlating measurements of spatially distributed quantities taken on the reactor with the lattice constants in the diffusion equations. The method can be used with any thermal reactor system of current interest, but the first application is to provide a replacement for the SAMSON code for Winfrith SGHW studies, where the measurements of interest are channel powers.

56461 (AEEW-R—1209) **DELILAH correlation code for adjusting the parameters of the one-group diffusion equations to give best estimate power distributions for thermal reactor systems.** Buckler, A.N. (UKAEA, Winfrith. Atomic Energy Establishment). Oct 1978. 34p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Details of the coding techniques, with flow diagrams are given for the correlation code DELILAH which is a replacement for the SAMSON code for SGHW and other thermal systems. An improved method of rejecting inaccurate channel power measurements is described in detail. A list of the input data requirements for the code will be published separately.

56462 (INIS-mf—4280, pp 207-214) **Irradiation experiments on the WWR-S reactor gas loop.** Pelcik, E. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

Experiments are briefly characterized carried out using the gas loop installed at the WWR-S reactor. The possibilities were studied of affecting by an electric field the heat transfer from fuel elements to the coolant ionized by the action of reactor radiation. In A-1 type fuel elements, overheating was studied of two smooth pins in the point of contact of the two pins, and radiation stability and heat conditions were investigated in a fuel element consisting of two concentric tubes from uranium metal enriched to 6.5% U 235, clad on both sides with a Mg-Be alloy, and in a fuel element consisting of a single tube with magnox cladding. The dimension changes of the fuel elements due to radiation, thermal and mechanical stresses in combination were studied with the aim of increasing the A-1 fuel element burn-up. Also tested were the function of calorimetric probes, the attachment of thermocouples to the fuel pin surfaces, the increase in radioactivity in the cooling gas owing to fuel element leakage was studied and in the last radiation experiment the effect of radiation on tensometric measurement was investigated.

56463 (INIS-mf—4470, pp vp) **Mechanical design considerations for a collapsible fuel cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The design of fuel elements for the pressurised heavy water reactors being built in India is based on thin zircaloy cladding of collapsible type dictated by the use of natural uranium dioxide fuel material. A thin cladding will be deformed from the beginning of irradiation by either the external coolant pressure or by a change in pellet outer geometry. In order to establish reliable design criteria for satisfactory performance during the life time, a thorough understanding of the behavior of such fuel elements is necessary. In this paper, the following problems related to structural stability associated with the use of thin-walled cladding are examined: (i) Longitudinal Ridge Formation. (ii) Circumferential Ridge Formation. (iii) Collapse into Axial Gaps.

56464 (INIS-mf—4470, pp vp) **Local strain in cladding tube due to radial pellet cracking.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A study was made to develop a method for evaluation of the local strain in a cladding tube of the Advanced Thermal Reactor due to radial cracking of a UO_2 fuel pellet. Effects of the number of cracks, initial crack width and the friction coefficient of a pellet-clad interface on behaviors of the local strain in a cladding tube were evaluated with a modelized experiment. A Zircaloy-2 ring specimen with inner diameter of 95 mm, height of 25 mm and wall thickness of 5 mm was expanded at room temperature with equally divided peripheral dice of a tool steel set in a specimen. The dice were divided into 8, 12 or 16 pieces. For each dividing number, two dice edge geometries were prepared, that is, not chamfered and chamfered by 2 mm. Strains of an external surface of the specimen were measured with 28 wire strain gages with gage length of 0.3 mm. The friction coefficient on the pellet-clad contact surface was not measured, but two friction conditions were prepared. One was metal-metal contact and the other was a contact surface coated with teflon film. The estimated friction coefficient was 0.1 for the former and 0.05 for the latter. An elastic-plastic analysis was carried out in order to evaluate the membrane hoop strain in the cladding tube. The analysis was made under two conditions. One was a plane stress condition of a radial and hoop stress which resembled the state of stress-strain developed in the ring specimen. The other was a plane strain condition of a radial and hoop strain which approximated the stress-strain state in a cladding tube.

56465 Flow-induced vibration analysis of heat exchanger and steam generator designs. Pettigrew, M.J.; Sylvestre, Y.; Campagna, A.O. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). pp F6/1 1/12 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Tube and shell heat exchange components such as steam generators, heat exchangers and condensers are essential parts of CANDU (CANadian Deuterium Uranium) nuclear power stations. Excessive flow-induced vibration may cause tube failures by fatigue or more likely by fretting-wear. Such failures may lead to station shutdowns that are very undersirable in terms of lost production. Hence good performance and reliability dictate a thorough flow-induced vibration analysis at the design stage. This paper presents our approach and techniques in this respect. The vibration excitation mechanisms and the dynamics of multispan tubes are formulated in a computer model. The model predicts tube vibration response and critical velocities for fluidelastic instability. A description of the model is given. The vibration analysis of a steam generator is outlined as an example.

56466 Repeatable boundary conditions and their application in the analysis of a complete CANDU fuel pin. Too, J.J.M.; Rigby, G.L.; Tamm, H. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). pp D1/8 1-14 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A simple repeatable boundary condition is introduced to overcome the difficulties usually associated with the finite element analysis of CANDU fuel pins. This boundary condition is deduced from the fact that, for CANDU fuel pins, the power distribution along the length of the pins of interest is essentially constant, with the exception of the flux peak at each end. This is true because of the short, 50 cm length fuel pins, and the extensively flattened axial fluxes in the physically large CANDU reactor cores. It is therefore conceivable that the thermal/mechanical behaviour of each pellet (except those near the end caps) is approximately the same. If a fuel pin is divided into regions, each region containing a number of finite elements covering one fuel pellet, then the temperature field and the displacement field can be assumed identical or repeatable for all regions. This use of periodic boundary conditions greatly reduces the number of equations required since all pellets not associated with the end region are represented by one equivalent pellet.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 56387, 56548, 56551, 56596, 56599, 56608, 56633, 56634, 56642, 56643, 56644, 56646, 56647, 56648, 56649, 56650, 56651, 56658, 56661, 56662, 56663, 56669, 56674, 56679, 56680, 56681, 56682, 56683, 56684, 56685, 56686, 56687, 56688, 56689, 56690, 56691, 56692, 56693, 56694, 56695, 56696, 56697, 56698, 56699, 56700, 56701, 56702, 56703, 56707, 56710, 56711, 56712, 56713, 56714, 56715, 56725, 56726, 56727, 56728, 56891, 56900, 56905, 56922

56467 (CEA-CONF—4192) **Utilization of the experimental reactor Osiris for the study and the development of fuels of the fast neutron reactor type.** Marcon, M.; Faugere, J.L.; Genthon, J.P.; Maillot, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 1977. 21p. (In French). (CONF-771189—5). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Symposium on the future of research reactors; Grenoble, France (Nov 1977).

Nuclear fuel tests for the fast neutron reactor type have been carried out at the Osiris reactor: thermal study of $(U,Pu)O_2$ oxide by measurement with thermocouples in the core of the fuel pellet; study of the effects of power cycling on nuclear fuel; study of the mechanical interactions between oxide and cladding by measurement of the cladding deformation during irradiation.

56468 (CEA-R—4881) **Manufacture of the second core of Rapsodie - Type 2 A - Fortissimo version.** Mandicourt, L. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Dept. de Developpement des Elements Combustibles). Nov 1977. 88p. (In French). Dep. NTIS (US Sales Only), PC A05/MF A01.

This report concerns the fuel manufacturing of the second core of RAPSODIE reactor 2 A type, FORTISSIMO version. This fuel is a mixed oxide of Plutonium and highly enriched Uranium. The manufacturing facility which is used, started in 1969, is essentially designed for the production of fuels with high percentage of fissile material. It includes devices used to produce the first RAPSODIE fuel and new machines resulting from technological improvements obtained during previous manufactures. The manufacturing process is described after a recall fuel physical characteristics. A final quantitative balance for the whole fabrication is presented. The results obtained on fuel pellets and pins are discussed with starting from the fabrication process and the changes which may have occured or arose from the use of different devices. A more theoretical approach of some particular problems is presented: the multiphasage, the amount of oxygen and the porosities. A general conclusion is given on the main theoretical and technical problems met on the manufacture of nuclear fuel of this type.

56469 (CONF-790802—51) **Fracture experiments with cracked and embrittled hexcan sections.** Petroski, H.J.; Yamada, H. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

Crack-like flaws that might exist in hexagonal subassembly ducts are not generally expected to initiate brittle fracture, but there is reason to be concerned about the integrity of cracked hexcans that have been severely embrittled by fast-neutron irradiation. In order to check the applicability of linear elastic fracture mechanisms analysis to such ducts, a program of experiments with deliberately cracked and embrittled hexcan sections has been undertaken. Type 446 stainless steel was used for the test sections because this material may be heat treated to alter its room-temperature mechanical properties to such an extent that they simulate those of irradiated 20% cold-worked Type 316 stainless steel at reactor operating temperature. Although these different materials are not metallurgically comparable in their fracture properties, the structural response of hexcan sections fabricated from Type 446 may be assumed similar to that of irradiated Type 316 stainless steel hexcans. A series of experiments involving several different crack depths at either the corners or midflats of hexcan sections has been begun. After heat treatment and fatigue-sharpening of the cracks, the duct sections were loaded at two opposite midflats, and the load vs crack opening displacement was recorded for each test. Earlier analytical work provides stress intensity factor calibrations for the test conditions, and these calibrations enable one to predict analytically the load at which brittle fracture could occur. In this paper, a comparison of these analytical predictions and experimental results will be made and discussed.

56470 (CONF-790802—56) **Comparisons of REXCO code predictions with SRI SM-2 experimental results.** Chang, Y.W.; Gvildys, J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 19p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

SRI International has performed a series of simple model (SM) experiments for the Clinch River Breeder Reactor Project (CRBR). The SM tests consisted of five experiments. The energy source used to simulate the core-disassembly accident loads was a PETN-microsphere mixture, which was well calibrated. These experiments were well instrumented and performed under carefully controlled conditions. The experimental data can be used as reliable test data for validation of computer codes, as well as the modeling technique used in the computer analysis. This paper deals with the REXCO-HEP code predictions of the SRI SM-2 test, which was a dynamic test performed on 1/20th scale model of the CRBR. Two calculations have been performed: one used the pressure history P(t) of the core detonation products as input, and the other the pressure-volume relation (P-V) of the detonation products as input. The pressure loadings and wall deformations obtained with the P(t) calculations are in better agreement with the experimental measurements than those obtained with the P-V calculations. This is because the P-V relations used in the code calculation were derived from the pressure gauge readings of the core gas, the measured surface motions of the slug and the calculated compressibility of the coolant; they may become less accurate at low pressures. Therefore, in performing code validation calculations, the pressure history of the core gas should be used in the analysis to describe the behavior of the core gas, if the P(t) values are available from the experimental data.

56471 (CONF-790802—59) **Effects of gap sizes on stresses and deflections of a fuel element.** Wu, T.S. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

Based on the simple beam theory and the principle of superposition, the elastic lateral deflection and flexural stress of wire-wrapped fuel elements were studied. In wire-wrapped fuel elements, the space wire provides potential contact points for neighboring fuel elements. The actual points of contact, however, depend on the deflection of the fuel element. The model used in this investigation consists of a cantilever beam with intermediate stops located at a distance g from the axis of the beam, where g is the gap size. Three values of g - 0, 0.051 mm (2 mil), and 0.127 mm (5 mil) - were used in this investigation. Results from two wire-wrapped fuel elements under their respective transverse thermal gradients show that both the number of contact points and the magnitude of the maximum reaction force are reduced as the value of g increases. In all cases considered, the maximum reaction force is acting at the stop farthest from the fixed end, and the maximum deflection occurs in the vicinity where thermal gradient had its peak value. Another expected result is that the maximum lateral deflection increases with the gap size. The largest deflection for all cases studied, however, is still much smaller than the radius of a typical space wire. This suggests that, under the conditions such as the ones considered here, direct contact between a fuel element and its adjacent member is very unlikely. The maximum flexural stresses with and without gap differ only slightly, and the relation between the stress and the gap size is not monotonic. Since a larger gap will only reduce stress slightly, but will cause larger deflection and therefore more positive thermal-hydraulic feedback, a smaller gap that is able to keep the maximum stress within the design limit should be favorably considered.

56472 (CONF-790802—73) **Transient analysis of LMFBR reinforced/prestressed concrete containment.** Marchertas, A.H.; Belytschko, T.B.; Bazant, Z.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The use of prestressed concrete reactor vessels (PCRVs) for LMFBR containment creates a need for analytical methods for treating the transient response of such structures, for LMFBR containment must be capable of sustaining the dynamic effects which arise in a hypothetical core disruptive accident (HCDA). These analyses require several unique features: a model of concrete which includes tensile cracking, a methodology for representing the prestressing tendons and for simulating the prestressing operation, and an efficient computational tool for treating the transient response. For the purpose of treating the transient response, a finite element program with explicit time integration was chosen. For the purpose of illustrating the applicability of these techniques and the validity of the models for concrete and the prestressing tendons, several example solutions are presented and compared with experimental results.

56473 (COO—2250-38) **MIT LMFBR blanket research project. Quarterly progress report, April 1-June 30, 1979.** Driscoll, M.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 25 Jul 1979. Contract EY-76-S-02-2250. 16p. Dep. NTIS, PC A02/MF A01.

In designing a plutonium-uranium core with thorium internal blankets there are several parameters that must be investigated to identify the design with the best performance. Choices include: the amount of moderation in the blanket, whether moderation is incorporated from the outset or added after an assembly is shuffled to the external blanket, and the cycle length both for the core and internal

blanket assemblies. To investigate the effect of these parameters several core and blanket burnup analyses were performed.

56474 (ECN—48) **Fast reactor programme. First quarter 1978 progress report.** Hoekstra, E.K. (Stichting Energieonderzoek Centrum Nederland, Petten). Sep 1978. 52p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Recently evaluated neutron capture cross section data of ^{142} ^{143} ^{144} ^{145} ^{146} ^{150}Nd, natural Nd and Mo as well as adjustment of the capture cross sections of ^{152} ^{154}Sm to fit integral data measured in STEK and CFRMF are discussed. The progress made with preparations for the HFR-TOP transient overpower experiments on fuel pins under irradiation in the pool-side facility of the HFR is reported on. Results are given of tensile tests on irradiated as well as on heat-treated stainless steel DIN 1.4948 specimens subjected to varying numbers of fatigue cycles. In the field of aerosol research, measured gas flow rates and pressure drops in stainless steel capillaries of various dimensions are compared with theory; the gas flow and aerosol penetration in cracks, artificially introduced in concrete test specimens, have been determined. Criteria in selecting the right light-scattering particles for use in Laser Doppler Anemometer measurements are given; the results of single and two-phase experiments with the second 28-rod bundle and the hydrodynamics during single-bubble boiling in the first bundle are discussed.

56475 (GEFR-SP—010) **Out-of-pile experiments performed in the U.S. Fuel Cladding Chemical Interaction (FCCI) Program.** Adamson, M.G. (General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center). 1977. Contract EY-76-C-03-0893-014. 69p. (CONF-770215—2). Dep. NTIS, PC A04/MF A01.

From Technical committee meeting on fuel and cladding interaction; Tokyo, Japan (21 Feb 1977).

Since 1972 a variety of out-of-pile experiments have been performed as part of the US National Fuel-Cladding Chemical Interaction (FCCI) Program. In the present paper results from these experiments are presented together with descriptions of many of the experimental techniques employed to obtain them. Although the main emphasis of the paper is on experiments designed to characterize FCCI with Type-316SS cladding, considerable attention is also paid to the following FCCI-related topics: thermodynamics of and phase equilibria in mixed oxide fuel and fission product compounds, fission product and cladding component thermo-transport, and chemical behavior of candidate oxygen-absorber materials (buffer/getters). Detailed interpretations of these results in terms of FCCI mechamisms are presented in a companion paper.

56476 (HEDL-TME—79-23) **Results from the run-beyond-cladding-breach irradiation of a predefected fuel pin (RBCB-6).** Langstaff, D.C.; Almassy, M.Y.; Washburn, D.F. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1979. Contract EY-76-C-14-2170. 61p. Dep. NTIS, PC A04/MF A01.

A slit was machined through the cladding of an irradiated fuel pin and irradiation in the Experimental Breeder Reactor-II (EBR-II) was resumed. The condition of the fuel pin was continuously followed with delayed neutron (DN) monitors. When the DN signal increased to a previously established administrative limit, the test was terminated. Postirradiation examination showed the sodium-fuel reaction caused fuel swelling and extension of the machined slit. There was no evidence of fuel loss nor was there any indication of impending pin-to-pin failure propagation. This test supports an increase in DN signal for subsequent run-beyond-cladding-breach (RBCB) tests.

56477 (IAE—2819) **Optimum symbiotic system of fission - fusion molten-salt reactors.** Blinkin, V.L.; Novikov, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 17p. (In Russian). Dep. NTIS (US Sales Only), PC A0?/MF A01.

The breeder fission-fusion symbiotic system has been studied. The uranium-233 is generated in the hybrid blanket of the controlled thermonuclear reactor (CTR) out of the thorium, which is circulating through the CTR blanket in the form of ThF_4 together with molten sodium and beryllium fluorides. Molten-salt fission reactor (MSR) burns up the uranium-233 and produces tritium out of lithium which is circulating through the MSR core in the form of LiF together with molten BeF_2 and $^{233}UF_4$. The symbiotic system ensures fuel breeding with fuel doubling time of 4-5 yrs and has the fusion to fission thermal power ratio about 1:2. The symbiotic system possesses the following features: The fuel reprocessing is simplier and cheaper than that in modern fission reactors. This reprocessing is: (a) uranium is removed out of circulating salt in CTR blanket by fluorination, (b) the volatile fission products are removed out of MSR fuel salt by helium-gas purge system, (c) the MSR fuel salt is periodically replaced with uranium-233 recover. The tritium production is realized in the fission reactor which is simplier system than CTR. The CTR blanket is almost "clean" as the tritium does not exceed the construction material induced activity. Almost all thorium loaded in the CTR blanket may be utilized for uranium-233 production.

56478 (IAE—2971) **Marginal thermal-neutron peak fluxes in systems with modulation of reactivity.** Alekseev, N.I.; Stolypin, V.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A possibility of obtaining high (including marginal) thermal neutron peak fluxes PHIsub(m) in a light water trap of a pulsed fast reactor with modulation of reactivity has been studied. The dependences of sub(m) on the subcriticality and supercriticality as well as on the supercritical state duration have been calculated on stepped variations of the reactivity. The calculations show that PHIsub(m) of about $7.3x10^{18}$ neutron/cm^{2}xs with the effective pulse duration of approximately 150 μc, pulse frequency of approximately 1 Hz and at fuel temperature of approximately 1300 deg C can be obtained with the reactor. The comparative calculations show that sub(m) is 1.5 times higher than that of a booster obtained using a "meson plant" (designs of the booster and the reactor are equivalent). The neutron background between pulses in the reactor is much lower than in the booster, and there is no need for a power injector in the reactor altogether. Meanwhile the maximum attainable PHIsub(m) for the booster and the reactor are the same and equal approximately $2x10^{19}$ neutron/cm^{2}xs.

56479 (INIS-mf—4280, pp 167-169) **Neutron transport by sodium pipes going through fast reactor shielding 20.** Burian, J.; Rataj, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

On the WWR-S reactor, neutron transport was studied through a straight cylindrical sodium conduit 400 mm in diameter as was neutron transport through a conduit with elbows, and the effects were investigated of gaps and insulation materials on neutron transport with the purpose of determining the neutron transport through the sodium conduit in the fast reactor shielding. 7 different types of detectors were used for neutron detection, the neutron flux distribution in complex geometry was studied by the three-dimensional Boltzmann transport equation using the Monte Carlo method by means of an IBM 370/135 computer. When sodium is surrounded by a thick iron layer, neutron transport through sodium is decisive for long distance transport. If there is a gap or insulation around the conduit, neutrons passing through this medium also affect the neutron spectrum in sodium.

56480 (INIS-mf—4280, pp 145-148) **Fast reactor optimization using nonlinear programming.** Jakab, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

A considerable number of fast reactor optimization problems may be formulated as nonlinear programming problems, which allows the automation of the optimization process by using the computer for evaluation of intermediate results and decision making. The speeds are compared of various minimizing methods in dependence on the number of variables. A programme was written in Fortran for the IBM 360/40 computer based on the gradient quasi-Newton method which belongs to the penalty function method group. Numerical experiments showed that the speed of determining the constrained extreme depended on the penalty constant and on the number of variables and constraints. An excessively low value of the penalty constant results in a procedure failure while an excessively high value causes the slowing down of the convergence. Increasing the number of variables extends the procedure while the dependence of the procedure speed on the number of constraints alone is insignificant.

56481 (INIS-mf—4280, pp 182-189) **Progress in the construction of experimental sodium loop SMT-1.** Paryzek, R.; Rezac, J.; Hasek, M. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

Experimental sodium loop SMT-1 being built in the Nuclear Research Institute is designed for heat technology research of fast reactor fuel assemblies and for research and development of sodium technology. In addition to the sodium circuit proper, the equipment will consist of sodium preliminary cleaning and disposal stations, a measuring and a control unit, a 1000 kVA power supply and a ventilation system. The sodium circuit is divided into two branches operating at temperatures of 500 and 600 degC, respectively. For this purpose, an air cooler is inserted in the circuit and a contactless ejector-type heat exchanger. The circuit will also be equipped with 7 electromagnetic flowmeters without iron core, a contactless sodium level indicator and with a system of sodium leak indication.

56482 (INIS-mf—4280, pp 170-181) **Institute's research into thermal parameters of fast reactor fuel assemblies.** Sulc, V.; Pasek, M.; Hrehor, M.; Masek, V.; Nechvatal, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

Temperature fields in fuel assemblies modelling the BN-600 reactor assemblies for the case of deflection of the side rod from the nominal position in the direction normal to the assembly wall were studied using the experimental sodium loop S III permitting operation at sodium coolant temperature of 400 degC. The experimental assembly consisted of 16 rods, temperatures were measured with thermocouples placed on a measuring rod in a regular helical configuration with a pitch of 856 mm. The first thermocouple was placed 5 mm from the beginning of the heated length, the last at a distance of 775 mm. This configuration made it possible to measure the temperature field both along the periphery and along the length of the heating rod. The temperature profiles along the periphery of the measuring rod showed along the entire length of the rod temperature maxima in two contact places, this for all heated rods.

56483 (INIS-mf—4470, pp vp) **Modeling of LMFBR fuel cladding mechanical behavior under transient conditions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Analytic methods must address the complexity of modeling fuel cladding response in situations where temperature, temperature gradient, strain rate, and stress are changing rapidly with time. Fuel cladding modeling is not a simple extension of the experimental and interpretative methods used in classical mechanics. New concepts are needed to describe materials in a reactor environment. Some aspects of continuum physics used to develop these new constitutive equations for fuel cladding are presented in this report. The theory of internal state variable, whose evolution is governed by ordinary differential equations, has been introduced into continuum mechanics. The components of the internal or hidden state variable vector may be scalers, components of vectors, components of second order tensors, etc. Irradiation, hardening, grain size, chemical reaction, etc., are scalar internal variables. Internal strain, dislocation loop density, etc., are all examples of second order tensors whose components are internal state variables. The internal state variables of this report are irradiation PHI which satisfies the neutron density conservation law, and hardening.

56484 (INIS-mf—4470, pp vp) **Effects of stress on swelling in reactor fuel cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this report is to describe the effect of stress on swelling in both annealed and 20% cold worked 316 stainless steel. An effect of stress on swelling in irradiated metals has been postulated for some time. Low fluence data confirmed that indeed a tensile stress can increase swelling in irradiated annealed 316 stainless steel and that the maximum swelling occurs at an intermediate stress level which is approximately equal to the proportional elastic limit of the material. The specimens discussed above were examined by transmission electron microscopy and an effect of stress on the microstructure of the annealed and 20% cold worked 316 specimens has been observed. However, as yet, copious swelling had not occurred in the 20% cold worked material. Specimens of 20% cold worked 316 fabricated from the same heat of material as those described above have now been irradiated to sufficiently high neutron fluences that swelling has occurred in both the annealed and cold worked conditions. The specimens were 2.5 cm long, biaxially pressurized tubes, with an OD of 0.58 cm and ID of 0.51 cm. Stress levels ranged from 0 to approximately 400 MPa. Specimens were irradiated in EBR-II to maximum fluences approximately 53 dpa. Swelling in the specimens was evaluated by pre- and post-irradiation immersion density measurements.

56485 (INIS-mf—4470, pp vp) **Analysis of crack patterns in fast reactor fuel pellets.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56486 (INIS-mf—4470, pp vp) **Variability of cladding deformation of LMFBR fuel elements.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56487 (INIS-mf—4470, pp vp) **Stress-strain properties of fast reactor fuel cladding under constant pressure transient heating conditions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56488 (INIS-mf—4470, pp vp) **Cladding failure by local plastic instability.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Cladding failure is one of the major considerations in analysis of fast-reactor fuel pin behavior during hypothetical accident transients since time, location, and nature of failure govern the early post-failure material motion and reactivity feedback. Out-of-Pile transient burst tests of both irradiated and unirradiated fast-reactor cladding show that local plastic instability, or bulging, often precedes rupture. The time and location of failure is then determined by conditions favorable to bulge formation. Furthermore, the extent of the local instability limits the initial rip length and the initial area available for motion of fuel and fission products from the pin. To investigate the details of cladding bulging, a perturbation analysis of the equations governing the large deformation of a cylindrical shell has been developed. The overall deformation history is assumed to consist of a small perturbation of the radial displacement superimposed on large axisymmetric displacements. Computations have been carried out using high temperature properties of stainless steel in conjunction with various constitutive theories, including a generalization of the Endochronic Theory of Plasticity in which both time-nt and time-dependent plastic strains are modeled.

56489 (INIS-mf—4470, pp vp) **LMFBR-fuel cladding thermal creep strain under linearly increasing internal pressure.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes an apparatus designed to simulate the continuously increasing internal pressure due to the accumulation of fission product gas. There is also an examination of the effects of increasing pressure on the thermal creep rate of cladding. Test specimens are 20% C.W. type 316 stainless steel tubes with 6.5 mm OD, 5.6 mm ID and 200 mm length. Increasing pressure creep tests were performed at 700°C, the hoop stress was increased in steps with 3 incremental rates of 0.15, 0.075 and 0.0375 kg/mm²h. Constant pressure creep tests were also performed at the same temperature for comparison. As mentioned above, calculations of creep behavior under increasing stress are normally made using the stationary creep rate obtained from constant pressure tests. Thus, it is important to know these creep rates agree with creep rates directly measured from strain-time plot under increasing pressure. The results show that the creep rates obtained from creep curves under increasing pressure are several times as high as the stationary creep rates measured under the same constant pressure. Creep strain rate under increasing pressure, due to the accumulation of gaseous fission products in the actual fuel cladding, is approximately 2 to 5 times that of the constant pressure creep rates, although the creep rate magnification depends on the stress and the stress-increase rate. Based on so-called time hardening theory and strain hardening theory, creep strain rate under increasing pressure is calculated using the strain-time plot under constant pressure.

56490 (INIS-mf—4470, pp vp) **Characterization of residual stress profiles in irradiated fuel pin cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Two specific applications for characterizing the residual stress in irradiated fuel pin cladding with limited, discrete data are developed in the paper. One represents a minimum effort approach and requires only four pairs of data. The end product is a 'curve' consisting of four linear segments that approximates the residual stress profile of the cladding specimen. The second technique is a semi-analytical technique for statistically fitting an assumed curve form to the data. The deformation of fueled cladding irradiation is a complex phenomenon. Modelling the deformation mechanism fuel pin cladding cannot provide detailed information fuel pin behavior without corroborative experimental data. The ability to determine the actual residual stress profile through the wall of a cladding specimen represents a new and powerful tool for evaluating cladding behavior.

56491 (INIS-mf—4470, pp vp) **Probabilistic design method for LMFBR fuel rods.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Fuel rod performance analyses for design purposes are dependent upon material properties, dimensions, and loads that are statistical in nature. Conventional design practice accounts for the uncertainties in relevant parameters by designing to a 'safety factor', set so as to assure safe operation. Arbitrary assignment of these safety factors, based upon a number of 'worst case' assumptions, may result in costly over-design. Probabilistic design methods provide a systematic way to reflect the uncertainties in design parameters. PECS-III is a computer code which employs Monte Carlo techniques to generate the probability density and distribution functions for time-to-failure and cumulative damage for sealed plenum LMFBR fuel rods on a single rod or whole core basis.

56492 (INIS-mf—4470, pp vp) **Statistical mechanical analysis of LMFBR fuel cladding tubes.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The most important design requirement on fuel pin cladding for LMFBR's is its mechanical integrity. Disruptive factors include

internal pressure from mixed oxide fuel fission gas release, thermal stresses and high temperature creep, neutron-induced differential void-swelling as a source of stress in the cladding and irradiation creep of stainless steel material, corrosion by fission products. Under irradiation these load-restraining mechanisms are accentuated by stainless steel embrittlement and strength alterations. To account for the numerous uncertainties involved in the analysis by theoretical models and computer codes statistical tools are unavoidably requested, i.e. Monte Carlo simulation methods. Thanks to these techniques, uncertainties in nominal characteristics, material properties and environmental conditions can be linked up in a correct way and used for a more accurate conceptual design. First, a thermal creep damage index is set up through a sufficiently sophisticated clad physical analysis including arbitrary time dependence of power and neutron flux as well as effects of sodium temperature, burnup and steel mechanical behavior. Although this strain limit approach implies a more general but time consuming model., on the counterpart the net output is improved and e.g. clad temperature, stress and strain maxima may be easily assessed. A full spectrum of variables are statistically treated to account for their probability distributions. Creep damage probability may be obtained and can contribute to a quantitative fuel probability estimation.

56493 (INIS-mf—4470, pp vp) **Analysis of fuel/clad mechanical interaction in non-steady reactor operation via fuel rod modelling code IAMBUS.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56494 (INIS-mf—4470, pp vp) **Experimental and theoretical evaluation of defect growth of fuel pin cladding by chemical fuel-sodium interaction.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the system fuel-sodium-oxygen a reaction product (Na_3MO_4), where M=U+Pu, is formed after attaining an equilibrium oxygen concentration in the sodium. The reaction product is characterized by a low density (e.g. 5.5 g/cm^3) and a low thermal conductivity (about 1/10 of that of the fuel). The melting point is about 1420^{0}C. The reaction was predicted previously by thermodynamic assessment for UO_2 and for mixed oxide. First estimates were made for O-diffusion through the fuel to the defect after falling below the equilibrium O concentration in sodium. Because of the small diffusion coefficient, the calculated diffusion time was large and the swelling rate of the defected pin was relatively low. There are now available some results of German irradiation experiments with defected pins in sodium. The measured swelling rates are much higher than the former predicted values.

56495 (INIS-mf—4470, pp vp) **2-D thermoelastic analysis of LMFBR fuel rod claddings.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The primary purpose of this study is twofold. Firstly, unique 2-D and 3-D temperature fields for bare finite rod bundles are presented which result from detailed distributed-parameter analyses using the slug flow model. Secondly, these results together with azimuthally varying inside and outside pressure fields are used to derive thermoelastic stress and displacement fields. The 2-D temperature fields are obtained by an iterative multicell, multiregion technique. Multicell calculations are especially important for studying the pronounced asymmetry effects induced by the coolant cells which are bounded by the bundle wall. The solution takes into account an arbitrary flow split between wall and internal subchannels as well as different heat source densities in the pins. Results indicate that the adiabatic single cell calculation is not conservative under all circumstances as has been previously assumed.

56496 (JAERI-M—7608) **Studies on heterogeneity effects in gas-cooled fast reactor.** Osugi, T.; Yoshida, H.; Ohta, F. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 110p. (In Japanese). Dep. NTIS (US Sales Only), PC A06/MF A01.

Heterogeneity effect in a gas-cooled fast reactor (GCFR) of power 1000 MWe, with helium-cooled pin type fuel, has been studied. Reactor characteristics (criticality, neutron spectrum, neutron flux distribution, power distribution, doppler reactivity effect, helium-void effect and steam ingress reactivity effect) are calculated at each burn-up step (T = 0, 1, 2 yr) with homogeneous and heterogeneous reactor constants. Cell calculation is made by collision probability method, and directional diffusion constants are based on Benoist's formula. Heterogeneity effect of in 300 MWe GCFR was also studied for comparison. Following are the results, (1) Heterogeneity effect on the criticality (multiplication factor) is -0.46%Δk/k. It decreases with burn-up. (2) Heterogeneity effect on the steam ingress reactivity effect varies with ingress steam density; 0.05%Δk/k for 0.01 g/cc, 0.12 for 0.03 and 0.14 for 0.05. It increases slightly with burn-up. (3) Heterogeneity effects on other reactor characteristics are insignificant. (4) Heterogeneity effects in 300 MWe GCFR are not much different from those in 1000 MWe GCFR.

56497 (LRC—5194) **CoMOX rod and bundle assembly and inspection: preliminary design study.** Woods, C.R. (ed.). (Babcock and Wilcox Co., Alliance, OH (USA). Contract Research Div.). May 1979. Contract EY-76-C-06-1830. 49p. Dep. NTIS, PC A03/MF A01.

A preliminary design study for a CoMOX fuel rod and bundle assembly facility has been made. The principal conclusions are that: (1) current LEU fuel fabrication processes can be adapted to CoMOX fuel with relatively minor modifications; (2) only a few pieces of equipment will require major development effort; and (3) no modification to the fuel design is necessary. It is concluded that going from LEU fuel to CoMOX fuel is an evolutionary step.

56498 (NIIAR-P—2(296)) **Radioactive impurities trapping by the BOR-60 cold trap.** Kizin, V.D.; Lisitsyn, E.S.; Poznyak, G.I.; Polyakov, V.I.; Chechetkin, Yu.V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 21p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Experimental studies were made to elucidate the accumulation of radioactivity in the standard cold trap (120 deg C) of the BOR-60 reactor. The most dangerous isotopes (possessing maximum specific radioactivity, long half-life period, gamma-quantum energy in excess of 600 keV) in the circuit of the fast reactor incorporating defective fuel elements are represented by isotopes of ^{137}Cs and ^{134}Cs. It is shown that in the cold trap the following isotopes are concentrated: ^{65}Zn, ^{134}Cs, ^{136}Cs, ^{137}Cs, ^{131}I, ^{60}Co, ^{124}Sb, and ^{22}Na. It should be noted that sodium in the trap is almost completely cleaned of iodine and tellurium, while the radioactivity of cesium, antimony and cobalt isotopes in the trap constitutes 20 - 30% of their content in the first circuit. It is established that the ability of the trap to catch cesium is not directly associated with its mutual precipitation with the oxides, sorption on the oxides or filtration. A conclusion is made that the cold traps do not represent an effective means of reducing the radioactivity level of the sodium coolant.

56499 **Analysis of bowed reactor cores using the FIAT-program.** Urban, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp D2/6 1-11 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The core elements of a LMFBR are bowed due to neutron flux and temperature gradients. The movement of the elements due to free bowing is restricted by neighbouring elements or contraint rings. Consequently forces are induced in the core. To calculate the forces and bowed shapes of the fuel elements at different power and burn-up situations the program FIAT was developed. FIAT is based on the NUBOW code of ANL. FIAT calculates the force equilibrium configuration of elements in a spoke treating the ducts as beam members. The iteration technique, which is taken from NUBOW, is used in FIAT to calculate the gap distribution between the pads of the elements in the considered spoke. Knowing the gap distribution a direct solution of the unknown mechanical displacements and forces in the load planes can be given. As the gap distribution hardly changes during the burn-up history, the use of the iteration part is not required very often. The computer running times of the combined method are about 10 times less than the strict iteration technique as used in NUBOW. The computer running time reduction is improving with increasing numbers of load planes between the elements. Other improvements of FLAT over NUBOW are bowing of elements due to neutron induced swelling and creep effects, and the growth of duct width due to pressure drop and creep (bulging).

56500 (NIIAR-P—5(299)) **Radioactivity of long-lived nuclides in the BOR-60 primary circuit during operation with some defective fuel elements.** Gryazev, V.M.; Kizin, V.D.; Lisitsyn, E.S.; Polyakov, V.I.; Chechetkin, Yu.V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 17p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Presented are the generalized results of measurement of the accumulation and distribution of the corrosion radioactive nuclides and fission products, which have been gained during four years of service of the BOR-60 reactor, including long-time operation of the defective fuel elements in the active zone. It is shown that when the quantity of the defective fuel elements amounts to about 1%, the radioactive situation becomes worse mainly owing to the escape of cesium radioisotopes and their accumulation in the coolant. As to other fission products, the maximum contribution to the dose rate of the pupelines and equipment is made by ^{140}Ba, ^{140}La and ^{95}Nb, When the quantity of the defective fuel elements equals 0.1-0.2%, this contribution is identical to the contribution made by the corrosion products of ^{60}Co and ^{54}Mn. The radioactivity of the corrosion products in the circuit has not increased within the last three years and has been by one order of magnitude below the calculated value. The corrosion and fission products are non-uniformly distributed in

the circuit. The concentration of ^{95}Nb and ^{60}Co in "cold" sodium pipeline was by 2- 5 times more, and concentration of ^{140}Ba and ^{54}Mn was by 10 - 20 times more, than in "hot" sodium pipelines. It has been estahlished that cobalt is deposited basically in the heat exchanger. The efficiency of coolant drain from the pipeline is estimated with a view to reducing the dose rate.

56501 (NIIAR-P—18(312)) **Determination of BOR-60 reactor dynamic characteristics using data from statistic experiments.** Adamovskii, L.A.; Kebadze, B.V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 18p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Considered are the problems associated with performance of a passive statistical experiment during investigation of the dynamic characteristics of an object. The procedure and equipment of the experiments conducted on the BOR-60 reactor are described. Presented is the procedure for calculating the pulse characteristic by reference to the experimental estimation of the correlation functions with the use of the regularization method. The efficiency of various types of regulators is described, and practical recommendations are given. Described are the results of measurements of the consumption - neutron flux in channels and those of the consumption - coolant temperature at the outlet of the reactor core, which have been obtained with the use of the standard transducers of the BOR-60 reactor measurement system. Analyzed is the effect of the non-correlated disturbance in the registered signal noise on the accuracy of measurements. Discussed are the problems of increasing the statistical accuracy of measurements and improving the procedure for recording and processing of the noises.

56502 (ORNL—5568) **Review of methods for treatment of source effects in the modified source multiplication method for monitoring the reactivity in refueling the CRBR.** Mihalczo, J.T. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 13p. AT.

There are three methods by which source effects can be treated in the interpretation of modified source multiplication measurements in refueling a liquid-metal fast breeder reactor: (1) measurement of and correction for axial and radial source intensity distributions; (2) use of an additional source to override burnt-in source effects so they can be neglected, and (3) calculations. The implementation of these methods and their adequacy for the Clinch River Breeder Reactor (CRBR) is discussed. Of the three methods, the use of an additional source is the only method where an increase or decrease in the count rate definitely means a corresponding increase or decrease in reactivity.

56503 (ORNL/TM—6956) **GCFR radial blanket and shield experiment: objectives, preanalysis, and specifications.** Ingersoll, D.T.; Bartine, D.E.; Muckenthaler, F.J. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 54p. Dep. NTIS, PC A04/MF A01.

An integral experiment has been designed for the verification of radiation transport methods and nuclear data used for the design of the radial shield for the proposed 300 MW(e) gas-cooled fast breeder reactor (GCFR). The scope of the experiment was chosen to include a thorium oxide radial blanket mockup as well as several shield configurations in order to reduce the uncertainties in the calculated source terms for the radial shield, and to reduce the uncertainties in the calculated radiation damage to the prestressed concrete reactor vessel (PCRV). Additionally, the measurements are intended to bound the uncertainties in calculated gamma-ray heating rates within the blanket and shield. Although designed specifically for the GCFR, the experiment will provide generic data regarding deep penetration in ThO_2 and common shield materials, which should also benefit LMFBR designers.

56504 (PNCT—831-77-02, pp 17-22) **Development of end plug welding method in the fabrication of FBR fuel pins.** Ohtani, S.; Sawayama, T.; Tateishi, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works). Sep 1977.

In Semi-annual progress report of Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, July-December 1976.

As a part of the development of the automatic and remote controlled fabrication of FBR fuel pins, welding of fuel pin end plugs has been examined. Cladding tubes and end plugs used for this experiment are made of SUS 316, and they are the components of fuel pins for the prototype fast breeder reactor (Monju) or the second core of Joyo (Joyo MK-II). The welding tests of cladding tubes and four kinds of end plugs were carried out by means of two techniques; tungsten inert gas welding and laser welding. It can be said that no considerable difference was observed in weld penetration, occurrence rate of weld defects and breaking strength between the tight fit and the loose fit plugs. The face-to-face fit welding requires the least welding heat input, but involves much difficulty in the control of weld penetration and bead zone diameter. The good concentrative property and high energy density of laser beam make the face of weld hollow due to the vaporization of weld metal. However, this problem can be easily solved by changing the shape of end plugs. Good results in the other characteristics of the weld also were obtained by this laser welding. Further experiment is needed in connection with the compatibility of weld metal with sodium and neutron irradiation before final judgement is made on the laser welding technique.

56505 (PNCT—831-77-02, pp 5-16) **Development of automatic surface defect inspection of fuel pellets. I. Detection principle and inspection method.** Shishido, T.; Kawasaki, T.; Tateishi, Y.; Matsuda, A.; Hanawa, A. (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works). Sep 1977.

In Semi-annual progress report of Power Reactor and Nuclear Fuel Development Corporation, Tokai Works, July-December 1976.

Automatic surface defect inspection of nuclear fuel pellets at the last stage of pellet fabrication process has been recently requested in order to reduce the radiation dose of operators. Especially, nuclear fuel such as PuO_2-UO_2 pellets must be set apart when they do not meet certain standards. Most of the fuel pellets are cylindrical sintered bodies with flat ends. The cracks, chips and fissures of these finished products have been inspected with eyes so far. However, such inspection is not accurate enough to find defects. Moreover, since fuel pellets are radioactive, mechanization of the inspection process is highly desirable in view of safety. At first, the inspection method with optical appliances was inadequate in the reliability and efficiency. In this paper, detection principle, inspection apparatus such as visual inspection machine, cylindrical-chip inspection unit, corner inspection device and cylindrical surface inspection device, and some experimental results, for example, correlation between defective areas and output pressure in corner inspection device, correlation between number of chips at the corner and output pressure, and correlation between output power and defective area on the pneumatic inspection method are reported.

56506 **Control of tritium in liquid-metal-cooled fast breeder reactors (LMFBRs).** McGuire, J.C. (Hanford Engineering Development Lab., Richland, WA (USA)); Renner, T.A. (Argonne National Lab., IL (USA)). *At. Energy Rev.*; **16**: No. 4, 657-695(Dec 1978).

In liquid-metal-cooled fast breeder reactors tritium originates principally in two locations, the fuel and the control rods. It is created in the fuel by ternary fission and in control rods by neutron interaction with the boron in B_4C. Tritium diffuses readily through the cladding material of these components and is carried by the sodium coolant throughout the primary circuit. From primary sodium it may diffuse through heat exchangers to the secondary circuit, be released to the cover gas, permeate reactor walls into the containment vessel, or be removed by the primary cold trap. Similarly, from the secondary sodium tritium may diffuse through the heat transfer surfaces of the steam generator, be released to the cover gas, permeate through reactor walls to auxiliary containment, or be removed by the secondary cold traps. Protective oxide films on the outside walls of the reactor vessels and sodium piping significantly reduce the permeation rate of tritium through the structural materials. In addition, tritium retention within the sodium containment is enhanced by coprecipitation with hydrogen in the cold traps. A substantial hydrogen influx to the secondary circuit as a result of steam-side corrosion and permeation through steam generator tubing provides a source of hydrogen that assists in tritium control. Once in the secondary circuit, hydrogen is either removed by the secondary cold traps or diffuses through the intermediate heat exchanger to the primary circuit. The hydrogen source term in a reactor is roughly 10^4 times greater than that for tritium. Therefore, in either the primary or the secondary circuit, sufficient hydrogen is available for efficient tritium removal by coprecipitation.

56507 **Comparison study on GCFR core support grid plate displacements among experimental, analytical and finite element model.** Chuang, A.S.; Chang, K.H.; Washington, C.E. (General Atomic Co., San Diego, CA (USA)). pp F5/2 1-13 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The core support grid plate for the gas-cooled fast breeder reactor (GCFR) is a thick perforated plate into which the fuel elements are inserted and locked. The grid plate should be designed sufficiently rigid to minimize bending due to all expected service loading which might splay the fuel elements apart and thus cause a reactivity change. In the analysis the equivalent solid material concept was used and the equivalent solid plate was treated, using a transversely isotropic elasticity theory. The general solution was derived for a simply supported plate subjected to a uniform load, including the solid outer rim effect. - For the finite element model, a two-dimensional axisymmetric solid element was used. The orthortropic material behavior at the perforated region was retained while the solid rim was modelled using isotropic material properties. During the comparison and correlation process among the three models, it was found that the effective elastic constants provided by

the ASME code were on the conservative side (results in large displacement).

56508 Modeling of LMFBR fuel cladding mechanical behavior under transient conditions. Bard, F.E. (Hanford Engineering Development Lab., Richland, WA (USA)). pp C4/3 1-12 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Some aspects of continuum physics used to develop the new constitutive equations for fuel cladding are presented in this report. The theory of internal state variable, whose evolution is governed by ordinary differential equations, has been introduced into continuum mechanics. The components of the internal or hidden state variable vector may be scalers, components of vectors, components of second order tensors, etc. Irradiation, hardening, grain size, chemical reaction, etc., are scalar internal variables. Internal strain, dislocation loop density, etc., are all examples of second order tensors whose components are internal state variables. The internal state variables of this report are irradiation, phi, which satisfies the neutron density conservation law, and hardening. The isotropic hardening plasticity theory used in conjunction with creep has been incorporated into a computer code called PECTCLAD and has been correlated to annealing tests of 20% cold-worked Type 316 stainless steel and to tensile tests of annealed Type 316 stainless steel cladding. This correlated model is used to accurately predict the tensile, burst, and Fuel-Cladding Transient Testing (FCTT) data for 20% cold-worked Type 316 stainless steel cladding over a wide range of temperatures, temperature rates and strain rate. An excellent comparison is obtained between the predicted and measured data.

56509 Simple steel/water model for preliminary studies of acoustic vibration in LMFBR. Bentley, P.G.; Firth, D.; Rowley, R.; Beesley, M. (UKAEA, Risley. Nuclear Power Development Establishment). pp F5/7 1-11 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

One source of vibration excitation in Liquid Metal Fast Breeder Reactor is the acoustic energy which is generated by the circulating pump and transmitted through the fluid to various structural components. To gain some preliminary understanding of the extent and magnitude of vibration in fast reactors therefore, a simple model has been constructed in which only the major components are represented. The modeling theory is discussed and it is shown that adequate representation of the steel/sodium reactor materials can be obtained in the model based on the use of steel/water. Appreciable stresses are found on all the components in the primary circuit, not necessarily only those close to the simulated pump source. After scaling them to reactor size and allowing for the source calibration, it is found that stresses are unlikely to be sufficiently high to cause damage. The possibility of higher stresses being produced by better acoustic/structure coupling, similar to that found in smaller laboratory experiments, is to be further investigated on the model.

56510 Thermal and stress analyses of meltdown cups for LMFBR safety experiments using SLSF in-reactor loops. Blomquist, C.A.; Pierce, R.D.; Pedersen, D.R. (Argonne National Lab., IL (USA)); Ariman, T. (Notre Dame Univ., IN (USA)). pp E4/4 1-11 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The test trains for the Sodium Loop Safety Facility (SLSF) in-reactor experiments, which simulate hypothetical LMFBR accidents, have a meltdown cup to protect the primary containment from the effects of molten materials. Thermal and stress analyses were performed on the cup which is designed to contain 3.6 kg of molten fuel and 2.4 kg of molten steel. Thermal analyses were performed with the Argonne-modified version fo the general heat transfer code THTB, based on the instantaneous addition of 3200 °K molten fuel with a decay heat of 9 W/gm and 1920 °K molten steel. These analyses have shown that the cup will adequately cool the molten materials. The stress analysis showed that the Inconel vessel would not fail from the pressure loading, it was also shown that brittle fracture of the tungsten liner from thermal gradients is unlikely. Therefore, the melt-down cup meets the structural design requirements.

56511 Subassembly bowing experience in EBR-II. Bottcher, J.H.; Hofman, G.L. (Argonne National Lab., IL (USA)). pp D2/9 1-7 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Bowing was not considered a problem in EBR-II until subassembly handling problems occurred. A typical handling problem, caused by top end deflection of the bowed subassembly, is centering of the subassembly removal mechanism over the subassembly. Another problem is excess loads of up to 375 kg that have been required to remove bowed subassemblies from their grid position. All of the bowed type 304 stainless steel subassemblies that created handling difficulties were given a post-irradiation examination. Correlation of the in-core bowing phenomena with the bowing data base required both an axial and radial thermal and flux characterization, consideration of the subassembly design, interpretation of swelling and creep behavior and a simple workable model that could incorporate these factors. A thermal hydraulics code, 'CLUSTER' was used to calculate the operating temperatures at sixty radial locations for each of nineteen axial sections along the hex duct. For this analysis a simple beam method was used with postulated radial restraint bounds in simulating intersubassembly loading. The results of this analysis showed that the bow at a neutron fluence of $>2.7 \times 10^{22} n/cm^2$, $E>0.1$ MeV, in these structurally varying subassemblies was highly thermal gradient dependent.

56512 From PHENIX to SUPER PHENIX: mechanical structures assuring reactor vessel tightness at main sodium pump penetrations. Chabassier, R.M.; Blateyrou, J.J. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation (SNECMA), 92 - Suresnes (France). Div. Hispano-Suiza); Roumailhac, J.F. (Compagnie d'Ingenierie pour les Reacteurs au Sodium (CIRNA), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). pp F2/6 1-12 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

It is shown how the mechanical problems concerning the tightness of main sodium pump penetrations through the deck of a pool type reactor have been solved in joint SNECMA - HISPANO-SUIZA/CIRNA studies. Extensive general studies have been performed and a comprehensive dossier of different possible solutions compiled. Whereever appropriate, information has been extrapolated from PHENIX experience. In the solution finally adopted, an elastic torus shaped ring, which forms a ball-and-socket type joint is used. A thin shell structure connects the bottom to the reactor internals in such a way as to permit both vertical and rotational displacements. Studies and calculation have been completed with the realization of a 1/5 scale model of the upper torus ring. Displacement, and angular and axial stiffness measurements have confirmed the validity of the hypotheses.

56513 Parametric investigation of dynamic fracture. Chopra, P.S.; Moustakakis, B. (Argonne National Lab., IL (USA)). pp D3/6 1-10 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents results of parametric finite element fracture mechanics analyses conducted to develop an analytical model for simulating dynamic brittle fracture. Although this work may have wider general application, the dynamic loads considered here are those that may arise due to rapid release of fission gases from a failed fuel element inside a subassembly duct in an LMFBR. The analyses were conducted on an edge-cracked panel with various configurations of primary and secondary flaws similar to those investigated for quasi-static fracture earlier by Chopra, et al. For the fracture configurations analyzed, the peak dynamic crack opening stresses (COS) in the vicinity of the crack tip exceeded the static values by a factor of approximately 1.5. The displacement between two opposing nodes behind the crack tip, called the crack opening displacement (COD), also was investigated. The dynamic COD was found to be approximately 1.3 times greater than the corresponding static value.

56514 Temperature and stress responses of clean evaporator tubes under oscillatory water rivulet action in DNB region. Chu, C.L.; Roberts, J.M.; Dalcher, A.W. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). pp F9/3 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56515 Two-dimensional heat conduction calculations on the pin cladding and coolant of a wire wrap bundle. Cornet, G. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp D3/3 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56516 LMFBR fuel assembly channel wall cross section optimization. Dubberley, A.E.; Johnson, D.P.; Punches, J.R.; McCandless, R.J. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). pp D2/2 1-9 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The problem addressed in this paper is the optimal design of an LMFBR fuel assembly channel, subject to realistic material properties, operating environment and reactor geometric limitations. An LMFBR fuel assembly channel is a hexagonal thin-walled tube surrounding the fuel pin bundle to facilitate fuel handling and to control the flow of coolant through the core. The environment results in a ballooning of the channel from its original hexagonal shape due to irradiation swelling, thermal and irradiation enhanced creep, and the elastic pressure deformation of the channel material. The cross-section shape of the hexagonal channel is limited primarily by the principal stress and the total channel radial growth. It is presently considered preferable that adjacent channels do not touch from channel ballooning due to concerns about safety and refueling considerations. A computer program, WALLOP, has been developed as described in this paper to derive the wall shape of such an optimum channel, given realistic design and material constraints. Within WALLOP, an initial cross-sectional shape is chosen and a beam model of the wall is used to determine the elastic deflection. The computer program sequentially perturbes the wall cross section and repeats the process until channel life is maximized. For prototypic 1200 MWe LMFBR cores, comparing uniform thickness channel walls and optimized cross section walls generally shows that wall optimization yields about a 25% to 50% increase in allowable channel life for the same amount of material.

56517 Computer anlysis of the influence of design parameters, materials properties and operation conditions on the irradiation behaviour of fast breeder fuel rods with oxide fuel. Elbel, H.; Jimenez, J.L. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). pp D1/6 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Due to the fuel swelling sufficient and appropriate void volume must be provided within the fuel rods of fast breeder reactors. This can consist of four parts: the gap between fuel and clad, the pore volume, the dishing volume, and a fabricated central hole. One task in developing fast breeder fuel rods is to find the optimal size and allocation of the void volume. SATURN-1 calculations have shown that the load onto the clad expected at power ramps depends heavily on three factors: thermal expansion of the fuel pellet (dependency on O/Me ratio, actual temperature level), healing of the peripheral radial cracks, and mechanical properties of the outer fuel region. The results of the computer analysis lead to the following conclusions; Pellet density and gap width must be chosen in such a way that in case of gap closure under the foreseen operation conditions a sufficiently large central hole has been formed unless an appropriate hole has been provided in fabricating the pellets. The larger the fabricated gap, the larger is the crack volume in the outer region of the fuel pellet when the gap has been that region. The decision for a higher smear density must be combined with a reduction of the target burnup. But this value can be higher for a lower frequency of power changes.

56518 Stress-strain properties of fast reactor fuel cladding under constant pressure transient heating conditions. Hunter, C.W.; Johnson, G.D. (Hanford Engineering Development Lab., Richland, WA (USA)). pp C4/7 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56519 Development of a finite-strain fuel-element model. Jankus, V.Z.; Shack, W.J. (Argonne National Lab., IL (USA)). pp D1/4 1-9 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The LIFE-III computer code has been developed to describe the steady-state performance of LMFBR fuel rods. The mechanical analysis in the original version of the code was based on the assumption that the strains in the fuel and the cladding could be considered as infinitesimal. However, this assumption is grossly violated in the vicinity of the central void. To provide a more accurate description of the mechanical behaviour of the fuel element, a finite-strain fuel-element model was developed. The finite-strain calculations in the modified code are based on an incremental analysis. The deformations are assumed to be axisymmetric. The fuel element is divided into a number ($<=10$) of axial segments. Each segment is assumed to be in a state of generalized plane strain. The deformation history of the fuel element is analyzed in discrete time steps, and the basic geometry of the element is updated after each time step. To carry out the calculation for nonlinear materials, each axial segment is divided into a number ($<=25$) of concentric cylindrical rings. The analysis maintanins the overall force equilibrium of each ring and enforces geometric compatibility between the rings. To test the adequacy of the formulation, the code was applied to a number of benchmark problems, and excellent results were obtained. Sample calculations with actual fuel pins show that the modified code gives more satisfactory results in the fuel regions near the central void. The finite-strain capability requires only a modest increase (approximately 5%) in computing time.

56520 Vibrational analysis of the SUPER PHENIX internal shells. Jeanpierre, F.; Livolant, M (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). pp F5/5 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56521 Thermal/hydraulic bowing stability analysis of grid-supported multi-pin bundles with differential swelling and irradiation creep. McAreavey, G. (UKAEA, Risley. Nuclear Power Development Establishment). pp D2/1 1-15 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Azimuthal variations of clad temperature in fuel pin bundles leads to pin bowing by differential thermal expansion. During irradiation in a fast flux further possibly more severe bowing is caused by differential neutron induced voidage swelling, which, being temperature sensitive, will also vary azimuthally. The problem of pin bowing in a fuel element cluster involves consideration of the thermal/hydraulic behaviour, allowing for both inherent and induced clad temperature non-uniformities, coupled with the restrained bowing behaviour, including differential thermal expansion, differential swelling, and irradiation creep. All pins must be considered simultaneously. In the temperature and stress ranges of interest thermal creep may be neglected. An existing computer code, IAMBIC solves the zero time thermal bowing problem for a cluster of up to 61 pins on hexagonal pitch, with up to 21 supports at arbitrary axial spacing. The present paper describes the basis of TRIAMBIC, a time dependent code which analyses the irradiation induced effects in fuel pin bunbles due to fast neutrons.

56522 Three-dimensional analysis for fuel pin deformations in an LMFBR assembly. Miki, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). pp D2/3 1-16 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new analytical method is presented for analyzing, in three dimensions, the mechanical response of fuel pins with wire spacers, to their thermal and neutronic environment in an assembly of a Liquid Metal cooled Fast Breeder Reactor (LMFBR). It analyzes the mechanical interactions of the fuel pins in the assembly corresponding to three directions, which form an angle of $\pi/3$ radians with one another, and is based on the mathematical relationship of the displacement at the contact points and the associated contact forces with respect to all fuel pins in a direction corresponding to one of three axes. The displacement of the fuel pin is composed of its three components in each of the three directions thus calculated. In particular this method makes it possible to take into precise consideration the two factors affecting the deformation of the fuel pins - (a) the mutual interaction of fuel pins and (b) the forced breeding of the fuel pins due to the deformation of the wrapper tube. Based on this method, a new computational code, the Subchannel Deformation Analysis Code for Wire-Wrapped Assemblies (SHADOW) has been developed which can be applied to seven kinds of wire-wrapped fuel assemblies with a number of fuel pins ranging from 7 to 169.

56523 Computerized thermal input for steam generator stress analysis. Moody, E.; Rico, L.G.; Skopp, G.H. (Atomics International Div., Canoga Park, CA (USA)). pp F9/5 1-11 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In order to perform structural analyses of the CRBRP steam generators which include the effects of various system thermal hydraulic transients, detailed thermal profiles must be developed and transmitted to the stress analyst in a usable form. A unique, semi-automated computer system has been developed to optimally accomplish this task. This method has enabled very rapid analyses of

complex thermal stress problems. For scoping purposes, simplified models have been used to determine the worst transients thus minimizing detailed analysis. The method has also permitted rapid analysis of the effect of design changes. While the method was developed for steam generator analysis, it is being applied, in full or part, to thermal stress analysis of other components resulting in significant engineering cost and time savings.

56524 Flow-induced vibration bench testing of reactor components. Mulcahy, T.M. (Argonne National Lab., IL (USA)). pp F6/8 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56525 LMFBR-fuel cladding thermal creep strain under linearly increasing internal pressure. Nakatsuka, M. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center). pp C4/8 1-11 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes an apparatus designed to simulate the continuously increasing internal pressure due to the accumulation of fission product gas. There is also an examination of the effects of increasing pressure on the thermal creep rate of cladding. Test specimens are 20% C.W. type 316 stainless steel tubes with 6.5 mm OD, 5.6 mm ID and 200 mm length. Increasing pressure creep tests were performed at 700°C, the hoop stress was increased in steps with 3 incremental rates of 0.15, 0.075 and 0.0375 kg/mm²h. Constant pressure creep tests were also performed at the same temperature for comparison. The results show that the creep rates obtained from creep curves under increasing pressure are several times as high as the stationary creep rates measured under the same constant pressure. Creep strain rate under increasing pressure, due to the accumulation of gaseous fission products in the actual fuel cladding, is approximately 2 to 5 times that of the constant pressure creep rates, although the creep rate magnification depends on the stress and the stress-increase rate.

56526 Response of a grid spaced fuel assembly to shipping environment. Pal, N.; Allen, D.C. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). pp D2/12 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a dynamic analysis approach for design verification of a grid spaced nuclear fuel under conditions of shipping and handling using prototypical test examples of transportation by truck. Analytical response results were obtained using representative trailer bed acceleration time histories which had been recorded earlier under simulated shipping by truck transport environment. Important parameters affecting response are identified. Recognizing that the analytical estimate of the fundamental periods of the GSA cannot be very accurate owing to the complex geometry, upper bounds on acceleration reponses were established using the standard response spectrum technique. Finally, the GSA design was verified by laboratory tests-both static and dynamic. Static tests were used to calibrate displacement response of the grid spacer tabs relative to the fuel rods. Prototypical dynamic shaking table tests were next employed in which the response of the GSA was determined in sinusoidal sweep type of excitation. Handling loads were represented by shock tests consisting of one-cycle impulses at various levels of acceleration. The results of laboratory testing were seen to reinforce credance of design verification by analysis of the GSA subjected to shipping and handling environment.

56527 Probabilistic design method for LMFBR fuel rods. Peck, S.O.; Lovejoy, W.S. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). pp C4/9 1-8 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Fuel rod performance analyses for design purposes are dependent upon material properties, dimensions, and loads that are statistical in nature. Probabilistic design methods provide a systematic way to reflect the uncertainties in design parameters. PECS-III is a computer code which employs Monte Carlo techniques to generate the probability density and distribution functions for time-to-failure and cumulative damage for sealed plenum LMFBR fuel rods on a single rod or whole core basis. The probability that some measure of rod performance will fall within given limits is estimated by the relative frequency with which the Monte Carlo samples fall within those limits. The PECS-III deterministic model is a one-dimensional structural analysis code. Cladding loading mechanisms considered include fission gas pressure, differential fuel-cladding thermal expansion, and differential fuel-cladding swelling. The model predicts thermal creep strain, irradiation creep strain, irradiation induced swelling, and cumulative damage fractions based on strain and time to rupture. In fuel rod design, it is oftentimes low probability events (e.g. failure) that are of interest. Importance sampling techniques are used in PECS-III to accurately reproduce the output distribution in the area of interest without the high cost of a large number of samples.

56528 Stress-intensity factors for irradiation-embrittled hexagonal subassimbly ducts. Petroski, H.J.; Glazik, J.L. (Argonne National Lab., IL (USA)); Achenbach, J.D. (Northwestern Univ., Evanston, IL (USA). Technological Inst.). pp D2/11 1-7 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the present work, the results of a finite-element analysis of the problem of a crack in a corner of a uniformly pressurized hexcan are reported, and they support the applicability of beam theory to the hexcan problem. In particular, modeling the hexcan corner as a cracked strip whose crack faces are loaded with the hexcan stress distribution has been found to give very good results for the particular hexcan studied. The finite-element results for uniformly pressurized hexcans have been used as the basis for computing stress intensity factors for cracks in non-uniformly loaded hexcans, under loading conditions that might simulate those of fission gas relaeased from failed fuel pins or other non-uniform accident loading conditions. A finite-element analysis also has been carried out for the cracked hexcan loaded by midflat forces. The results of the different techniques are compared, and the simple model of a cracked strip loaded with the hexcan stress distribution is found again to agree closely with the finite-element results for the hexcan considered. However, the weight function technique is expected to apply to geometries for which the strip model is inadequate and to hold over a wider range of crack sizes.

56529 Statistical mechanical analysis of LMFBR fuel cladding tubes. Poncelet, J.P.; Pay, A. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp C4/2 1-14 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The most important design requirement on fuel pin cladding for LMFBR's is its mechanical integrity. Disruptive factors include internal pressure from mixed oxide fuel fission gas release, thermal stresses and high temperature creep, neutron-induced differential void-swelling as a source of stress in the cladding and irradiation creep of stainless steel material, corrosion by fission products. Under irradiation these load-restraining mechanisms are accentuated by stainless steel embrittlement and strength alterations. To account for the numerous uncertainties involved in the analysis by theoretical models and computer codes statistical tools are unavoidably requested, i.e. Monte Carlo simulation methods. Thanks to these techniques, uncertainties in nominal characteristics, material properties and environmental conditions can be linked up in a correct way and used for a more accurate conceptual design.

56530 Experiments on the response of hexagonal subassembly ducts to internal pressure pulses. Romander, C.M.; Cagliostro, D.J. (Stanford Research Inst., Menlo Park, CA (USA). Poulter Labs.). pp E3/4 1-9 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The safety of Liquid Metal Fast Breeder Reactors depends in part on the ability of the hexagonal subassembly ducts (hexcans) to withstand accidental internal radial loads so that damaged hexcans can be removed from the reactor core. To predict deformations and strains in hexcans subjected to these internal loads and in hexcans surrounding the damaged hexcan, Argonne National Laboratory has developed the finite-element, two-dimensional structural code STRAW (Structural Transient Response of Assembly Wrappers). The experiments described here were performed to verify the modeling techniques used in STRAW and to determine the effects of material properties on hexcan response. Pressure pulses were applied in 12-inch-long hexcans of annealed, 20% CW, and 50% CW 316 stainless steel. The results of these experiments are presented in a form suitable for verifying two-dimensional structure codes designed to predict the response of hexagonal subassembly ducts to internal pressures.

56531 Structural analysis of experimental carbide fueled driver assmbly flow duct for testing in the FFTF. Rowe, G.H.; Mehta, D.D.; Desaulniers, W.E. (Combustion Engineering, Inc., Windsor, CT (USA)). pp D2/10 1-14 of Structural mechanics in reactor technol-

ogy. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Mixed carbide fueled driver assembly experiments will be tested in FFTF fuel driver positions as part of the National Advanced Fuel Program. The design of the experiment flow ducts must assure conformance to FFTF functional requirements in addition to service as a test vehicle for the carbide fuel irradiations. Test goals of damage fluence burnup, and fluence to burnup ratio exceed those of the standard oxide fueled drivers. As a consequence, the 20% cold worked type 316 stainless steel material of construction will experience significant irradiation induced creep and swelling. Additionally, the flow duct design must withstand the enhanced thermal transients produced by the action of carbide fuel during reactor scrams. A major FFTF functional requirement is that adjacent flow ducts do not touch each other except at the load pads. This requires a realistic analysis of the creep and swelling deformation of the flow duct during an experiment lifetime. Flow duct dilation, i.e., diametrical growth of the hexagonal cross section, was investigated by the MARC-CDC finite element program. Subroutines for irradiation creep and swelling were incorporated into the program.

56532 Proof tests of irradiated EBR-II ducts. Ruther, W.E.; Staffou, J.D.; Chopra, P.S.; Lambert, J.D.B.; Srinivas, S. (Argonne National Lab., IL (USA)). pp D3/7 1-8 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Permanent deformation and fracture of subassembly ducts due to potential pressure pulses generated by the discharge of fission gas from fuel elements are important considerations in determining the burnup limit of fuels in LMFBR's. This paper discusses the results of a series of dynamic pressure tests that were conducted on intentionally defected irradiated EBR-II subassembly ducts. The tests were designed to simulate failure of a fuel element in a cluster of such elements. The major objective of the tests was to provide complete assurance that cladding failure of a driven-fuel element, which might conceivably cause rapid release of stored fission gas, would not deform or otherwise damage subasembly ducts in a way that would hinder movement of a control rod. The test program described provides a reliable method of assessing the failsafety of LMFBR ducts. The test procedure is particularly important since present analytical solutions cannot adequately model the subassembly and the reactor conditions.

56533 Initial pressure spike and its propagation phenomena in sodium-water reaction tests for MONJU steam generators. Sato, M.; Hiroi, H.; Tanaka, N.; Hori, M. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). pp E5/6 1-12 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

With the objective of demonstrating the safe design of steam generators for prototype LMFBR MONJU against the postulated large-leak accident, a number of large-leak sodium-water reaction tests have been conducted using the SWAT-1 and SWAT-3 rigs. Investigation of the potential effects of pressure load on the system is one of the major concerns in these tests. This paper reports the behaviour of initial pressure spike in the reaction vessel, its propagation phenomena to the simulated secondary cooling system, and the comparisons with the computer code for one-dimensional pressure wave propagation problems.

56534 Effect of tube-support interaction on the dynamic response of heat exchanger tubes. Shin, Y.S.; Jendrzejczyk, J.A.; Wambsganss, M.W. (Argonne National Lab., IL (USA)). pp F6/5 1-11 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

To avoid detrimental tube vibration in heat exchangers, resonant conditions and instabilitites must be avoided, and/or peak dynamic amplitudes must not exceed allowable limits. In attempting a theoretical analysis, questions arise as to the effects of tube/support interaction on tube vibrational characteristics (i.e. resonant frequencies, modes, damping) and response amplitude. As a part of ANL's Flow-Induced Vibration Program in support of the Clinch River Breeder Reactor Plant (CRBRP) steam generator design activity, tube/support interaction experiments are being performed not only to gain the insight into the dynamic behavior of CRBRP steam generator tubes, but also to provide the basis for developing design guidance. Test results were compared with anaytical results based on multispan tube with 'knife-edge' supports at the support locations.

56535 Model for pressure in an LMFBR duct due to discharge of gas from a failed fuel pin. Srinivas, S.; Chopra, P.S. (Argonne National Lab., IL (USA)). pp D3/5 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper an analytical model for the calculation of pressure pulses in hexagonal ducts due to discharge of gas from a failed fuel pin is developed. The analysis yields the time history of the pressure pulse which can be used in the calculation of permanent deformation of the duct or in the assessment of the susceptibility of the duct to fracture. The real physical situation of gas discharging through a pin in a duct filed with liquid is complex to model. Here the phenomenon is modeled based on some reasonable assumptions. In this model the analysis is divided into two stages. In the first stage the gas expands as a spherical bubble, but the influence of the duct wall is taken into account. At the end of the first stage the spherical shape of the bubble is assumed to be lost and the gas is assumed to expand axially as a column. The analysis involves solving the continuity and momentum equations for the liquid along with the energy balance equation for the gas.

56536 Analysis of fuel/clad mechanical interaction in non-steady reactor operation via fuel rod modelling code IAMBUS. Steinmetz, B.; Gehr, H.L.; Toebbe, H. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp C4/12 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56537 Simulation study of the secondary rupture of SG tubing for LMFBR. Tsuyuki, T. (Ishikawajima-Harima Heavy Industries Co. Ltd., Yokohama (Japan). Yokohama No.2 Works). pp E5/7 1-10 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

It is known that defects in a heat transfer tube of an LMFBR SG (steam generator) can be a cause of water leakage, which, eroding the adjacent tubes away (wastage), may lead to a large-scale water leakage (water injection) and water-sodium reaction. This paper, which is a part of a large research program for safety design of SG, intends to present and discuss the results of a simulation study made to determine the water injection rate and the tube fracture aspect as a function of the wastage shape.

56538 Effect of large sodium-water reactions on LMFBR steam generators: initial results from SWAAM-I. Valentin, R.A. (Argonne National Lab., IL (USA)). pp E5/1 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56539 Experimental and theoretical evaluation of defect growth of fuel pin cladding by chemical fuel-sodium interaction. Weimar, P. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). pp C4/6 1-12 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the system fuel-sodium-oxygen a reaction product (Na_3MO_4), where M = U + Pu, is formed after attaining an equilibrium oxygen concentration in the sodium. The reaction product is characterized by a low density (e.g. 5.5 g/cm^3) and a low thermal conductivity (about 1/10 of that of the fuel). The melting point is about 1420°C. The reaction was predicted previously by thermodynamic assessment for UO_2 and for mixed oxide. First estimates were made for O-diffusion through the fuel to the defect after failing below the equilibrium O concentration in sodium. Because of the small diffusion coefficient, the calculated diffusion time was large and the swelling rate of the defected pin was relatively low. There are now available some results of German irradiation experiments with defected pins in sodium. The measured swelling rates are much higher than the former predicted values. With two irradiation experiments of the German Fast Breeder Project SILOE S2 and MOL 7B it is now possible to discuss the effects of chemical fuel sodium reactions. The time dependence upon the swelling reaction was studied with a single pin in the French SILOE reactor and the long term behaviour of a failed 18 pin bundle in a sodium loop in the Belgian BR2 reactor was evaluated. The S2 pin showed a diameter increase of 25% after 50 d of irradiation. The respective values of the bundle after running 180 d beyond failure were some 30%. An evaluation of the pin defects referring to their orientation showed significant blockade in the colder channels of the bundle.

56540 2-D thermoelastic analysis of LMFBR fuel rod claddings. Wolf, L.; Wong, C.N.; Yeung, M.K. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). pp C4/4 1-16 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The primary purpose of this study is twofold. Firstly, unique 2-D and 3-D temperature fields for bare finite rod bundles are presented which result from detailed distributed-parameter analyses using the slug flow model. Secondly, these results together with azimuthally varying inside and outside pressure fields are used to derive thermoelastic stress and displacement fields. The 2-D temperature fields are obtained by an iterative multicell, multiregion technique. Multicell calculations are especially important for studying the pronounced asymmetry effects induced by the coolant cells which are bounded by the bundle wall. The solution takes into account an arbitrary flow split between wall and internal subchannels as well as different heat source densities in the pins. Results indicate that the adiabatic single cell calculation is not conservative under all circumstances as has been previously assumed. Integral mixing transport parameters which account for local temperature variations are quite different from those which are built into the subchannel codes and should be preferred in the future. The pin model used in these studies incorporates the following features: tilted power distribution as experienced across blanket rods, eccentric pellet position as the most probable pellet location at BOL, cracked pellet under higher burnup conditions.

56541 Mechanical response of FFTF reference and P1 cladding tubes under transient heating. Youngdahl, C.A.; Pierce, R.D.; Lepacek, B.E. (Argonne National Lab., IL (USA)); Ariman, T. (Notre Dame Univ., IN (USA)). pp C4/11 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56542 Development of the PCRV steam generator cavity closure for the GCFR. Dodge, W.G.; Robinson, G.C.; Callahan, J.P. (Oak Ridge National Lab., TN (USA)). pp H6/6 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56543 Influence of sodium temperature, gamma heating and wall thickness on design strength of SLSF containment vessels. Thompson, D.H.; Tessier, J.H.; Wang, P.Y.; Lennox, D.H. (Argonne National Lab., IL (USA)). pp G9/7 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56544 Behavior of annealed type 316 stainless steel under monotonic and cyclic biaxial loading at room temperature. Ellis, J.R.; Robinson, D.N.; Pugh, C.E. (Oak Ridge National Lab., TN (USA)). pp L8/4 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56545 Some trends in constitutive equation model development for high-temperature behavior of fast-reactor structural alloys. Pugh, C.E.; Robinson, D.N. (Oak Ridge National Lab., TN (USA)). pp M6/5 of Structural mechanics in reactor technology. Vol. M. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56546 (IEA-DT—048) **Streaming effect in gas-cooled fast breeder reactors.** Collussi, I. (Instituto de Energia Atomica, Sao Paulo (Brazil); Sao Paulo Univ. (Brazil). Escola Politecnica). [nd]. 77p. (In Portuguese). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

The importance of neutron streaming in the GCFR is evaluated by taking into consideration the anisotropy due to coolant and control rod channels. Calculation is done using a numerical-analytical method developed in this paper and compared with results obtained using the methods of Benoist and Ligou. Comparison of the results obtained by these three methods shows that streaming effect is strongly dependent on the axial buckling 'B^2_z'. The influence of neutron streaming on the reactivity is shown to be negligilbe and, in consequence, the GCFRs may be considered homogeneous to a good approximation. For accurate calculation the neutron streaming should be considered, mainly for radiation damage and shielding calculation.

REGULATION AND LICENSING

56547 (AED-Conf—77-540-001) **Legal questions concerning the licensing procedure of power plants - legal questions concerning the immediate enforceability.** Papier, H.J. (Bielefeld Univ. (Germany, F.R.)). (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 35p. (In German). (CONF-7709164—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Meeting on legal questions concerning the licensing procedure of power stations; Koeln, F.R. Germany (29 Sep 1977).

By making provisions for immediate enforceability, the FRG's law presents the executive in the field of industrial and energy-generating large-scale projects with an instrumentarium with which to react politically active and responsible to situations such as, for instance, energy shortage, implications and difficulties in the field of foreign politics, defense policies, and national economy, while at the same time the risk is taken into account that in individual cases of administrative quashing of sentences in licensing procedures malinvestments are made. Cases have grown fewer that constitutionally official bodies of State leadership, and the executive supporting them, make political decisions which they put into practice on their own responsibility.

ECONOMICS

FUEL CYCLE

REFER ALSO TO CITATION(S) 56384, 56409, 56430

56548 (AED-Conf—78-011-000, pp 1-2) **Nuclear investigations of sodium-cooled fast breeders with uranium-plutonium or thorium-uranium cycles.** Wehmann, U.; Strehlen, U. 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56549 (AED-Conf—78-011-000, pp 1) **Investigating the sensitivity of natural uranium in reactor strategies.** Heinecke, J.; Henssen, H.; Koenigsdorf, E. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56550 (AED-Conf—78-011-000, pp 1-2) **Aspects of the enlargement of energy reserves with the aid of thorium.** Jacke (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1978. (In German).

From KTG technical meeting on the recycling of fissile materials obtained in the various reactor types from the point of view of reactor design; Juelich, F.R. Germany (24 Jan 1978).

56551 (INIS-mf—4316, pp 3-7) **Investigation of the nuclear power system considering the operation of NPP with N_2O_4 cooled fast reactors.** Nesterenko, I.E.; Tsirikhova, V.Ya. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). 1977. (In Russian).

In Dissociating gases as coolants and working fluids in power plants. III.

Studies were made to elucidate the change of natural uranium consumption within 40 years in the nuclear power system with thermal reactors, fast sodium-cooled reactors put into operation by 1981 and fast reactors cooled with nitrogen tetroxide, depending on the comission time of the latter. The natural uranium consumption decreases by a factor of 2 when putting fast N_2O_4-cooled reactors into operation by 1986 and by a factor of 1.6- by 1996 as compared to the version of a nuclear power system with thermal and fast sodium-cooled reactors. Thus, from 1995 till 2000 year fast convertors are not required, and the system begins to operate on bred plutonium.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 57360

56552 (AEEW-R—1186) **FACADE version of JOSHUA.** Roth, M.J.; Thompson, M.A. (UKAEA, Winfrith. Atomic Energy Establishment). Jul 1978. 28p. Dep. NTIS (US Sales Only), PC A03/MF A01.

JOSHUA is a computer program, which simulates the neutronics, hydraulics, burn-up and refuelling of water cooled reactors. Its neutronics data in the form of macroscopic cross-sections are normally prepared by a lattice cell program such as WIMS. The method of transfer of data from WIMS to JOSHUA has been simplified by the use of the FACADE system. This report describes the input to the version of JOSHUA that uses FACADE.

56553 (IAE—2776) **Complex program for BESM-6 calculation of one-dimensional nuclear reactors by means of the multigroup-constant computer library (ARADAR).** Glushkov, E.S.; Petushkova, N.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 30p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Described is the ARADAR program used to solve one-dimensional multigroup equations of the reactor in the P_1-approximation. The program is written in the FORTRAN-ZERN language, is realized at the BESM-6 computer, and is automatically connected with the library of microscopic constants, that includes 46 chemical elements. In the program a method is used, based on the analytical solution of the diffusion type equation with the known right part. The results of test calculations are presented.

56554 (IAE—2777) **Abstract of programs for nuclear reactor calculation and kinetic equations solution.** Marakazov, A.A. (ed.). (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 48p. (In Russian). Dep. NTIS (US Sales Only), PC A04/MF A01.

The collection includes about 50 annotations of programmes,developed in the Kurchatov Atomic Energy Institute in 1971-1976. The programmes are intended for calculating the neutron flux, for solving systems of multigroup equations in P_3 approximation, for calculating the reactor cell, for analysing the system stability, breeding ratio etc. The programme annotations are compiled according to the following diagram: 1.Programme title. 2.Computer type. 3.Physical problem. 4.Solution method. 5.Calculation limitations. 6.Characteristic computer time. 7.Programme characteristic features. 8.Bound programmes. 9.Programme state. 10.Literature allusions in the programme. 11.Required memory resourses. 12.Programming language. 13.Operation system. 14.Names of authors and place of programme adjusting.

56555 (IAE—2926) **Group constant preparation for nuclear reactor calculations on the BESM-6 computer. ARAMAK-F program complex.** Lobyntsev, V.A.; Timofeev, I.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 31p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Described is the ARAMAK-F program complex - a FORTRAN version of the ARAMAKO program complex - which is used to calculate macroscopic and blocking microscopic neutron constants on the basis of the 26-group system of microscopic constants with an account of resonance cross section structure in subgroup presentation. All programs are written in the FORTRAN language for the BESM-6 computer. The program texts and check test problem are presented.

56556 (ITEF—9(1978)) **Optimization of xenon transients for limited rates of power variation with the account of spatial inhomogeneities.** Gerasimov, A.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1978. 27p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

An optimization method of xenon transients for limited values of xenon poisoning and power variations is developed with the account of spatial inhomogeneities of the fuel and neutron flux distributions. The time dependence of the neutron flux is assumed not to affect its spatial distribution. The account of the spatial inhomogeneities is performed by the method of spatial momenta. The solution of the general problem is reduced to the solution of several problems in the point models in the perturbation theory. Numerical solutions using the optimization method show that the iterations converge well and already the zero approximation yields an adequate result.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 56716, 56879, 56880, 56906, 56947, 56948, 56949

56557 (AED-Conf—78-031-001) **Welding of thick-walled containers - selected examples.** Cerjak, H.; Schmidt, J. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 13p. (In German). (CONF-780156—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Meeting on the welding of containers and pipes; Muenchen, F.R. Germany (30 Jan 1978).

The welding of thick-walled containers is discussed under the aspects of construction and design, materials selection, choice and qualification of the method of production, the production process and testing, using the example of reactor components. It is shown how the welding construction can be optimized by using selected materials in connection with optimum, continuously controlled production and processing methods.

56558 (CONF-770807—, pp vp) **Design and analysis of reactor containment of steel-concrete composite laminated shell.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new scheme of containment consisting of steel-concrete laminated shell is being developed. In the main part of a cylindrical vessel, the shell consists of two layers of thin steel plates located at the inner and outer surfaces, and a layer of concrete core into which both the steel plates are anchored. Because of the compressive and shearing resistance of the concrete core, the layers behave as a composite solid shell. Membrane forces are shared by steel plates and partly by concrete core. Bending moment is effectively resisted by the section with extreme layers of steel. The thickness of the shell is divided into n layers which are able to slip against each other at the contact surface. In order to validate the feasibility and safety of this new design, the results of analysis on the basis of up-to-date design loads are presented.

56559 (CONF-790802—57) **Effects of cracks on the response of shell structures.** Petroski, H.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 11p. (P). 02.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A simple model that predicts the effects of axial cracks on the elastic deformation of thin cylindrical shells has been developed. This model provides an efficient tool for performing parametric studies and for interpolating, extrapolating, and generalizing finite element analyses. The model employs Fourier series representations for the deformation components of the shell and represents a crack by pairs of concentrated couples at the crack location. These couples induce bending modes of deformation, with the lower order bending modes dominating the response. Hence excellent results can be obtained with only about twenty-five bending modes superimposed on the axisymmetric breathing mode, which alone characterizes the response of an uncracked shell to an axisymmetric pressure load. The model can be calibrated from a single static finite element analysis of the shell of interest. The calibrated model then accurately predicts the effects of different numbers, sizes, and locations of cracks under both static and dynamic loading of the shell.

56560 (ECN—46) **Inelastic finite element analysis of a pipe-elbow assembly (benchmark problem 2).** Knapp, H.P.; Prij, J. (Stichting Energieonderzoek Centrum Nederland, Petten). Sep 1978. 45p. Dep. NTIS (US Sales Only), PC A04/MF A01.

In the scope of the international benchmark problem effort on piping systems, benchmark problem 2 consisting of a pipe elbow assembly, subjected to a time dependent in-plane bending moment, was analysed using the finite element program MARC. Numerical results are presented and a comparison with experimental results is made. It is concluded that the main reason for the deviation between the calculated and measured values is due to the fact that creep-plasticity interaction is not taken into account in the analysis.

56561 **Significance of load biaxiality to the fracture problem.** Liebowitz, H.; Eftis, J. (George Washington Univ., Washington, DC (USA)). pp G5/1 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56562 (GKSS—78/E/31) **Self-powered detectors with thulium emitters.** Haller, P.; Klar, E.; Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1978. 3p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

Apart from fission chambers also self-powered (SPN) detectors are used to measure the neutron flux density in power reactor cores. With the present results, it should be possible to optimize the design of SPN detectors with Tm emitters in order to keep the parasite current components low enough. This detector would have a good useful signal/spurions signal ratio even during longer periods of use in the reactor core.

56563 **Embedment instrumentation for prestressed concrete pressure vessels.** Naus, D.J.; Callahan, J.P. (Oak Ridge National Lab., TN (USA)). pp H5/6 of Structural mechanics in reactor technology.

Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56564 (KFKI—1977-83) **TIBSO - A program system for the calculation of the production, transfer, life cycle and radiation of radionuclides in a compound nuclear reactor system.** Vertes, P. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Oct 1977. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The goal of the program system TIBSO is the calculation of production, transfer, cumulation and filtration of radio isotopes in the cooling system of an atomic power plant. There is no restriction on the complexity of the cooling system, only the linearity and the time independence of technological parameters are assumed. The report contains the description of the basic idea of the method, the solution of the set of linear equations to be used and the description of the internal library files developed.

56565 (LA-UR—79-2185) **Noise reduction of fuel pin images with a diffraction filter.** Miller, E.L.; Han, K.S. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 12p. (CONF-790816—43). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

The quality of noisy images can be improved by summing several simular but statistically independent images that have been obtained either using a series of fluors in a stack intercepting the radiation from a single pinhole or by using multiple pinhole arrays or other coded apertures. An optical method of performing this addition is being explored for fuel pin imaging, and is presented here along with experimental results. In addition, the extension of this method to the simultaneous display of depth planes of a three-dimensional source is discussed.

56566 Cathodic protection of nuclear power plants. Piazza, J.L. II. (Harco Corp., Houston, TX). pp 5p, Paper A 78 130-7 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

Cathodic protection is successfully used to avoid dangerous corrosion of nuclear power plants. The fundamental factors in the design and installation of these systems are summarized. Successful cathodic protection installations are described. Details of the systems are discussed from the preliminary survey through the design and selection of materials to the final construction and inspection. Potential pitfalls are described.

56567 Advances in fracture mechanics analysis of primary system performance under operating and accident conditions. Lynu, E.K.; Serpan, C.Z. Jr. (Nuclear Regulatory Commission, Washington, DC (USA)). pp G4/1 1-10 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The methods of Linear Elastic Fracture Mechanics and of Elastic Fracture Mechanics have been validated for prediction of pressure vessel performence by the Intermediate Vessel Test program results at the Oak Ridge National Laboratory. The test results from both hydraulically and pneumatically loaded vessels are in very good agreement with the pretest predictions of vessel failure for the given conditions of pressure, temperature, material, properties, and type and size of flaw. A second advance in fracture mechanics technology has been made in thermal shock analysis. This advance has been verified by the confirmatory results of testing small thick-walled cylinders under thermal shock conditions in the Heavy Section Steel Technology program, and of warm prestressing tests at the U.S. Naval Research Laboratory. The analyses developed in these efforts have shown that operational pressure-temperature transients can be effectively modeled and applied to pressure vessel materials having appropriate mechanical properties simulating radiation embrittlement, and that the crack initiation/arrest conditions predicted will occur. Thirdly, the technology of crack arrest has reached a level wherein standardization of test specimens and testing methods is now possible and, indeed, is underway. The detailed factors which affect arrest of running cracks, and how those factors must be evaluated to permit determination of a minimum toughness descriptive of crack arrest are better understood.

56568 Two- and three-dimensional finite element analysis of a central cracked crackgrowth test specimen. Prij, J. (Stichting Energieonderzoek Centrum Nederland, Petten). pp G4/2 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper several methods to extract K, the stress intensity factor, from the finite element results are applied and discussed for the case of the central cracked crack growth test specimen as used at ECN for crack growth experiments. The singular stress field is dealt with by meams of distorted and collapsed isoparametric elements. The numerical results from three-dimensional analyses performed with the finite element program MARC are presented. In evaluating K special attention is given to the plane stress-plane strain state in these analyses as the stress state along the crack front varies from plane strain in the midplane through a three-dimensional state into a plane stress state at the surface. The effects of the thickness on the stress distribution and the stress intensity factors appearing from the numerical results are dicsussed. The different numerical procedures to estimate the Ksub(I) values all show a variation of the calculated Ksub(I) values along the crack front. The range of this variation depends upon the numerical procedure applied.

56569 Improved stress-intensity factors for semi-elliptical surface cracks in finite-thickness plates. Rajn, I.S.; Newman, J.C. Jr (National Aeronautics and Space Administration, Langley Station, VA (USA). Langley Research Center). pp G5/8 1-14 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this paper is to present accurate stress-intensity factors for shallow and deep semi-elliptical surface cracks in plates using a three-dimensional finite-element analysis. To verify the accuracy of the solutions, convergence was studied by varying the degrees of freedom in the finite-element models. These models were composed of singular elements around the crack front and isoparametric elements elsewhere. Mode I elastic stress-intensity factors were calculated by using a nodal force method. To establish the validity of the present method, two problems: (1) a circular (penny-shaped) crack and (2) an elliptical crack buried in a very large body subjected to tension were analyzed. The results obtained from the present method for these crack shapes were within 1 percent of the exact solutions obtained from the literature.

56570 Finite element analysis of crack propagation problems for the fracture mechanics evaluation of reactor vessel nozzle junction. Ramani, D.T. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). pp G4/6 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56571 Elastic analysis of torispherical toriconical, and ellipsoidal pressure vessel heads. Ranjan, G.V. (Failure Analysis Associates, Palo Alto, CA (USA)); Steele, C.R. (Stanford Univ., CA (USA). Dept. of Mechanical Engineering). pp G7/6 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56572 Non-linear analysis up to rupture of a model of a multi-cavity prestressed concrete pressure vessel. Rebora, B.; Uffer, F.; Zimmermann, T. (Ecole Polytechnique Federale, Lausanne (Switzerland)). pp H3/4 1-14 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Within the frame of a German-Swiss agreement concerning the project of a high-temperature nuclear plant (HHT), the Swiss Federal Institute for Reactor Research (EIR, in Wuerlingen) has developed an integrated variant of an helium-cooled high temperature reactor of 3x500 Mwe. A test on a model (1:20) of this prestressed concrete nuclear vessel with multiple cavities has been carried out under the supervision of 'Bonnard et Gardel ingenieurs-conseils SA (BG). The aim of this analysis is to determine the mechanism of ruin and ultimate load of the structure. In addition, comparison with the results of the test emphasizes the mathematical model with a view to its utilisation for the analysis of any prestressed concrete nuclear vessel. The principal interest of this paper is to show the accuracy of non-linear analysis of a complex massive structure with the test results and the evolution of the behaviour of the structure from the apparition of the first crack up to the ruin by rupture of the steel wires.

56573 Analysis of cracks by means of FEM. Reynen, J. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp G5/6 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

FEM techniques are presented to define stress intensity factors for arbitrary 2D and 3D thermo-elastic crack problems. For 3D problems energy techniques are compared to the classical and a more refined displacement substitution method using 1/4 point singularity elements. For 2D problems an efficient implementation of crack closure work is developed introducing the Lagrangian multiplier technique. Physically the Lagrangian multipliers represent the crack closure forces. However, in the displacement method they are dealt with as unknowns added to the vector of unknown DOF. Using substructuring techniques the Gaussian elimination is arranged such that the Lagrangian multipliers are dealt with lastly and a superelement is generated. Numerical examples are given concerning thermo-elastic crack problems in primary pressure barriers.

56574 Some comments about the J_1 integral criterion in post yield fracture mechanics. Roche, R.L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). pp G3/2 1-17 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Several criteria have been proposed for Post Yield Fracture Mechanics. One of the most interesting ones is the J_1 integral. When the behaviour of material is elastic (even non-linear) it can be shown that J_1 is not path dependent (for a straight crack without thermal stresses). For this reason, it may be considered that J_1 characterizes the crack tip singularity. Extension is easy to deformation-type elastic plastic material, but there is no proof of path independence for flow-type plastic material (incremental plasticity or creep). Experimental results are often given as a proof of J_1 criterion validity, but there is no experimental value of a contour integral and assumptions are made in the use of experimental results. The main assumption implies that the received mechanical work (strain energy) is not dependent on the loading history (is only dependent on mechanical state). A general method to assess J_1 path dependence can be founded on the 'defect vector' (or driving force) concept. It can be shown that the resultant of defects included in a volumne is the J integral on the surface surrounding the volume (and L for the moment). In order to have an empirical idea of the J_1 path independence, it is possible to make computations with finite elements method. Some results are given and it seems that no noticeable path dependence is seen with simple shapes and radial (proportional) loading. A few cases with complex way of loading are also studied.

56575 Application of the J-integral concept to cracks emanating from a hole. Ruijtenbeek, M.G.v.d; Broekhoven, M.J.G. (Technische Hogeschool Delft (Netherlands)). pp G3/4 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Fracture of flawed heavy section steel stuctures such as LWR pressure vessels is generally preceded by considerable plastic deformation ahead of the crack tip, thus reguiring application of elastic plastic fracture mechanics (EPFM) concepts. This holds in particular for areas with high nominal stress and strain where yielding may occur even in the absence of flaws, e.g. nozzle corner regions. One such EPFM concept is the J-integral concept, currently arousing considerable interest mainly because of its potential to yield a fracture toughness characterizing parameter from small specimen tests. However, studies aimed at verification of the applicability of this concept to actual structures are very scarce. The present study is aimed at such a verification by a combined theoretical and experimental approach for the case of through-cracks emanating from a hole in a plate.

56576 Pressure vessel fracture safety investigations using as criterion the onset of crack propagation. Sahgal, S. (Nordostschweizerische Kraftwerke A.G., Doettingen. Kernkraftwerk Beznau); Varga, T.; Junker, M.; Shakeshaft, M. pp G1/4 1-14 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

For the nuclear pressure vessel frangible behavior can be normally excluded. The critical material characteristic at fracture, Ksub(IC), is with linear elastic fracture behavior of steels near to the onset of crack growth. With elastoplastic material behavior of the onset point of the stable crack growth and the actual fracture may be well apart. The 5% secant method is here of little use. The onset point can be down to 60% of the Psub(max). As a lower bound criterion the onset of stable crack growth is proposed. This point is detected on RPV steel by acoustic emission method and confirmed with heat tinting tests.

56577 Application of probabilistic fracture mechanics to the reliability analysis of pressure-bearing reactor components. Schmitt, W.; Roehrich, E.; Wellein, R. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp G6/2 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Since no failures in the primary reactor components have been reported so far, it is impossible to estimate the failure probability of those components just by means of statistics. Therefore the way of probabilistic fracture mechanics has been proposed. Here the material properties, the loads and the crack distributions are treated as statistical variables with certain distributions. From the distributions of these data probability density functions can be established for the loading of a component (e.g. the stress intensity factor) as well as for the resistance of this component (e.g. the fracture toughness). From these functions the failure probability for a given failure mode (e.g. brittle fracture) is easily obtained either by the application of direct integration procedures which are shortly reviewed here, or by the use of Monte Carlo techniques. The most important part of the concept is the collection of a sufficiently large amount of raw data from different sources (departments within the company or external). These data need to be processed so that they can be transformed into probability density functions. The method of data collection and processing in terms of histograms, plots of probability density functions etc, is described. The choice of the various types of distribution functions is discussed. As an example the derivation of the probability density function for cracks of a given size in a component is presented.

56578 Geometric influences upon stress intensity distributions along reactor vessel nozzle cracks. Smith, C.W.; Jolles, M.I.; Peters, W.H. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Engineering Science and Mechanics). pp G4/3 1-8 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes the results obtained by applying a computer assisted photoelastic technique developed by the senior author and his associates for estimating Mode 1 stress intensity factor (SIF) distributions for mathematically intractable three-dimensional problems to the reactor vessel nozzle corner crack problem. Two significantly different test programs were employed and results were compared with the literature. Frozen stress photoelastic experiments were conducted on two classes of nozzle corner cracks: (1) Researchers at the Delft University Laboratory for Nuclear Engineering have developed a nozzle-flat plate geometry which is loaded in remote uniaxial tension normal to the flaw. The transverse tension can then be included analytically. Their results indicate that such a model accurately predicts fatigue crack growth for the corresponding cracked nozzle in a pressure vessel for thin walled vessels. The test geometry identified as No. 4 in the Delft work was studied experimentally in the present work. (ii) Researchers at Oak Ridge National Laboratory developed a technique for predicting SIFs in cracked nozzles in thick walled pressure vessels from residual static strength tests on fatigue cracked plastic models of nozzle-cylinder interactions. The test geometry identified as the 'small thick walled vessel' in the Oak Ridge program was studied experimentally in the present work.

56579 Cracked element approach for the computation of stress intensity factors. Spiering, R.M.E.J.; Pater, C.de (Technische Hogeschool Twente, Enschede (Netherlands)). pp G5/7 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of the work is to evaluate the influence of different matching conditions between a cracked element and the surrounding regular elements upon the stress intensity factors or plane problems. The influence of size and type of the elements has been studied as well. The cracked element is a polygon with a linear crack. The coordinate system has its origin at the crack tip and the negative x_1-axis along the crack. The work is based upon the complex variable formulations of Muskhelishvili for homogeneous isotropic material. The stresses and displacements are written as series expansions of the complex variable in the x_1-x_2 plane, taking into account the condition of traction free crack surfaces. The stress intensity factors Ksub(I) and Ksub(II) corresponding to the crack edge opening resp. sliding mode can be found directly from the coefficient of the first term of one of the stress functions.

56580 Analysis of saddle supported horizontal pressure vessels. Stoneking, J.E.; Sheth, H.H. (Tennessee Univ., Knoxville (USA). Dept. of Engineering Science and Mechanics). pp G7/8 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56581 Local response of elastic tubes and shell to spherical pressure pulse loading. Thompson, J.J.; Holy, Z.J. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering). pp B2/3 1-9 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper develops a formulation and numerical solution technique for calculating the peak transient stresses developed in tubes or shells with external and internal acoustic media, as a result of shock loadings which may be represented as originating from external or internal point symmetric or dipole sources. The field of application is intended to be the local peak response of cylindrical fuel cans, core barrels, pressure vessels, pipes and containment shells of Nuclear Reactor Technology, subjected to transient pressure shock loadings for a variety of operational or accident conditions, which cannot adequately be described as one dimensional plane shocks, for which elastic shell responses have been presented by other workers. The work reported here concerns the basic problem of an infinite static fluid filled hollow cylinder of arbitrary thickness in an infinite static fluid medium, with a source at an arbitrary internal or external radial location. An acoustic model is used, with acoustic damping due to radiation as the only possible damping mechanism. The formulation and solution technique is based on the availability of the multi-dimensional Fast Fourier Transform algorithm. The basic result is the representation, in cylindrical coordinates, of the two dimensional (time and axial co-ordinate) Fourier Transform of the infinite medium frequency response function for outgoing waves from a point symmetrical source, as a series of azimuthal Fourier harmonics, from which the result of a dipole source of arbitrary orientation follows.

56582 Nonlinear analysis of prestressed concrete reactor pressure vessels by finite elements. Valente, G. (Rome Univ. (Italy)). pp H2/6 1-16 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The web reinforcement is subdivided into linear elements and the concrete body into axialsymmetrical elements with triangular radial section. It is assumed that the stress field and the velocity field are linearly interpolated within each element independently from each other, and that the continuity conditions across the interface of neighbouring elements are satisfied. The steel is assumed to behave as a perfectly plastic material, and von Mises yield criterion is adopted for it. For bond stresses between steel and concrete, it is assumed to behave rigidly up to the yield stress derived from experimental data obtained by Nilson, and then in a perfectly plastic way. The failure function of concrete is a non-homogeneous convex fourth order polynomial. In this way, whatever the type of concrete being examined may be and if the values sigmasub(c), sigmasub(c)' of the ultimate strengths of concrete under uniaxial tension and compression are known, a valid analytical expression of the failure function can be deduced.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 56895, 56896, 56897, 56899, 56920, 56924, 56945

56583 (CEGB-RD/B/N—4339) **Effect of load factor on fission product decay heat from discharged reactor fuel.** Davies, B.S.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jul 1978. 5p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A sum-of-exponentials expression representing the decay heat power following a burst thermal irradiation of ^{235}U has been used to investigate the effect of load factor during irradiation on subsequent decay heat production. A sequence of random numbers was used to indicate reactor 'on' and 'off' periods for irradiations which continued for a total of 1500 days at power and were followed by 100 days cooling. It was found that for these conditions decay heat is almost proportional to load factor. Estimates of decay heat uncertainty arising from the random irradiation pattern are also given.

56584 (CONF-790802—60) **Formulation for the analysis of pellet-cladding mechanical interaction.** Liu, Y.Y.; Meyer, J.E.; Argon, A.S. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38 19p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A formulation has been derived for the thermoelastic analysis of pellet-cladding mechanical interaction. The formulation is based on a combination of finite element analysis and the matrix-displacement method. Boundary conditions at the pellet-cladding and pellet-pellet contacting sites can be treated realistically by considering the force and displacement relationships at the interfaces. As a result, no simulating gap elements need be used and the analysis of the two limiting cases, fuel-cladding bonding (stick) and fuel-cladding slippage (slip), follows directly from imposing the appropriate boundary conditions. From the principle of superposition, this formulation also gives a very compact scheme which can be used to study a variety of power ramp cases with ease. No additional finite element analysis is required after the solutions for a number of individual base-case problems have been obtained. Because of thermoelastic response of a fuel-element during a power ramp corresponds to that for a fast ramp rate, which subjects cladding to the most severe mechanical loading, the results from our thermoelastic analysis can be very useful in evaluating the likelihood of cladding failure when they are combined with knowledge of the cladding failure mode (plastic instability or stress-corrosion cracking). Since the failure mode for the Light Water Reactor fuel elements is predominantly stress-corrosion cracking and there is generally no time-independent cladding plastic deformation during a power ramp, our formulation may be applied directly to provide an assessment of the permissible power ramps. This could lead to a relaxation of the current restrictive and empirically based reactor-operation rules.

56585 (IAE—2785) **Short description and instructions to the program for temperature and velocity field calculation.** Segal, M.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 13p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Given are a short description and an instruction to the programme of calculating temperature and velocity fields. Considered is the flux in a cluster of heat-generating bars as in a tube with bulk energy and friction sources. The flux is described with a system of three-dimensional non-linear equations of the parabolic type. The solution is found in each of the nodes of a spatial radially-azimuthal grid. The number of layers along the cluster does not exceed 50. The number of nodes in the cross section is limited in complience with the relation $M^2N(<=)1450$, where M is a number of steps over the azimuth, N - a number of steps over the cluster radius. All thermal physical properties of the coolant depend on the temperature. The constant libraries for helium and air are envisaged, with the possibility of introducing thermal physical constant for other gases as well. The computer type is BEhSM-6. The necessary memory volume - the programme operates with a fictitious extended memory only. The programme language is FORTRAN. The operation system is "Dubna". Presented is a list of the incoming and outgoing information and the description of main subprogrammes.

56586 (INIS-mf—4470, pp vp) **Optimal rate of power increase in nuclear fuel pellet behavior under dynamic conditions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A mathematical model has been developed for the determination of the optimum power escalation rate for nuclear power plants from the view-point of fuel integrity. The model, TRANS, calculates the stress and strain transients in pellet-cladding systems with rapid power increases. No burnup effects are included due to the short time scale involved. An elastic solution has been transposed to a linear viscoelastic one, using the correspondence principle. The cladding has, however, been treated under the programme assumptions as purely elastic. The fuel material has been considered to be completely relaxed prior to the power transient. Radial cracking is included. The UO_2-material distortion has been assumed to be linear viscoelastic, while the dilatation elastic. The system has been treated assuming plane strain. Axial and rotational symmetry was applied. The results of the calculations show that under the above assumptions the cladding strain is independent of the rate of power increase in the pellet. Since this result is in opposition to general opinion, an experimental programme was performed confirming the results. A thermal gradient furnace was built for out-of-pile experiments. The experimental unit consisted of three pellets with central holes, which were held in a titanium tube serving as a cladding. The principal result, i.e. that the radial displacement is independent of time constant, agreed with theory. In general, the theoretical curves lie below the experimental ones, which is to be expected because of the assumptions of an elastic cladding.

56587 (INIS-mf—4470, pp vp) **Iterative model for calculating the crack structure in fuel rod design.** 1977. (In German).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The model developed to calculate the crack structure is within the scope of the URANUS fuel rod code, which gives a thermal and mechanical analysis of integral fuel rod behavior. As the fuel rod geometry in the URANUS-code is idealized as a quasi two-dimensional description, the model can take local effects into account only by their average values. The basic assumptions of the model are: a) cracks are substituted by means of fictitious crack strains; b) cracks may occur perpendicular to radial, tangential and axial direction. The theory is developed in extension to the classical

theory of plasticity. An iterative procedure is given combining plasticity and crack calculation. During this iterative procedure criteria are established which decide whether assumptions concerning plasticity or crack structure during the step (m) are still valid for the step (m+1). The final results of this iterative procedure are physically meaningful: a) in a region of plasticity the stress is on the yield surface; b) perpendicular to a crack surface the stress is given by an average value which may be a function of the history.

56588 (INIS-mf—4470, pp vp) **Design for thermal stresses in probabilistic form in clad fuel plates.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents equations for the mean values and standard deviations of thermal stresses developed in flat elements. These include clad fuel plates with uniform heat generation in the fuel zone and flat plate claddings with exponential heat generation. Inherent in these equations are the facts that (1) design variables are generally characterized by spectra of values, rather than by unique values, and (2) a small, but finite, probability of failure must be recognized in any design. By coupling the stresses due to the applied loading as calculated by the equations given in the paper with the strength available in a material, reliability (or the alternative probability of failure) can be calculated. Conversely, for a given reliability the appropriate dimensions can be determined. Appropriate illustrations of application of these equations are provided through tables and figures. The difficulty of relying on a factor of safety is demonstrated. As an example, consider a clad flat fuel element with uniform heat generation in the cladding, and symmetrical temperature and stress distributions. In one configuration with a given set of parameters using mean values and deterministic equations, the factor of safety is found to be 2.06. Use of means and standard deviations through the probabilistic equations indicates one probable failure in 100,000 elements. If the standard deviation of the unit conductance at the interface between fuel and cladding is doubled, there are two probable failures in 100,000 elements. There is no change in the factor of safety. If the standard deviation of the heat generation rate is doubled, the factor of safety is still 2.06 but the probable failure rate increases to one in 10,000.

56589 (INIS-mf—4470, pp vp) **General linear thermoelastic end problem for solid and hollow cylinders.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper reports on three topics arising from work in progress on theoretical and computational aspects of the utilization of self equilibrating and load stress systems, to solve thermoelastic problems of finite, or semi-infinite, solid or hollow circular cylinders, with particular reference to the pellets, rods, tubes and shells with arbitrary internal heat generation encountered in Nuclear Reactor Technology. Specifically the work is aimed at the evaluation of stress intensification factors in the end elastic boundary layer region, due to various thermal and mechanical end load conditions, in relation to the external, exact stress solutions, which satisfy conditions on the curved surfaces only and are valid over the remainder of the cylindrical body. More generally, it is possible, at least for symmetric thermoelastic problems, to derive exact external solutions, using self equilibrating end load systems, which describe the stress/displacement state completely as a combination of a simple local plane strain solution and a correction dependent on the magnitude of axial thermal gradients. Thus plane strain, and self equilibrating end load systems are sufficient for the complete external and boundary layer solution of a finite cylindrical body. This formulation is capable of further extension, e.g., to concentric multi-region problems, and provides a useful approach to the study of local stress intensification factors due to thermal perturbations.

56590 (INIS-mf—4470, pp vp) **Asymmetric fracture of fuel element pellets.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a linear, elasto-static analysis of a cracked fuel element pellet in a state of plane strain. The pellet cross-section is taken to be circular with n equally spaced, equal length cracks extending from the outer circular boundary towards the center. It is assumed that the fuel rod has not come in contact with the surrounding cladding and is subjected to an arbitrary but axisymmetric thermal field. The problem is reduced to considering an iso-thermal problem where the crack faces are subjected to a normal traction p(r) being given in terms of the known thermal field. The stress and displacement fields are first represented in terms of Bromwich integrals and infinite series. Satisfaction of all of the boundary conditions in the mixed boundary value problem leads to a single set of dual integral equations involving one unknown. An alternate formulation valid for long cracks and large n is readily achieved if the role of the circular boundary is neglected. Considering the problem of an infinite plane cut by n equal length, equally spaced cracks emanating at infinity and extending towards the coordinate origin leads to the desired mixed boundary value problem. In this second problem the crack faces are subjected to the same traction p(r) as in the first problem, it is just that the circular boundary has been assumed to not interact with the crack tips. The results are presented in terms of the crack tip stress intensity factor which is a measure of the severity of the stress field at the crack tips. A complete parameter study is presented for a range of values of n and crack length for the special case of a thermal field arising from the uniform generation of heat throughout the cross-section.

56591 (KFKI—1977-97) **COBRA - 3C/KFKI: a digital computer program for steady and transient thermal-hydraulic analysis of rod bundle nuclear fuel elements.** Vigassy, J.; Kovacs, L.M. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Nov 1977. 21p. Dep. NTIS (US Sales Only), PC A03/MF A01.

COBRA-3C/KFKI is a digital computer program for the CDC-3300 computer in FORTRAN language. The program is a revised version of the original COBRA-3C code. The code calculates steady-state and transient flow and enthalpy transport in rod-bundle nuclear fuel elements in both boiling and nonboiling conditions. The mathematical model is formulated by dividing the bundle flow area into flow subchannels that are assumed to contain one-dimensional flow and are coupled to each other by turbulent and diversion crossflow mixing. The program neglects sonic velocity propagation but allows for a temporal and spatial acceleration of the diversion crossflow in the transverse momentum equation. A semiexplicit finite-difference scheme is used to perform a boundary-value solution where the boundary conditions are the inlet enthalpy, inlet flow rate and exit pressure.

56592 (STUDSVIK-BL—78-2) **Fission product migration in intact fuel rods. S176 experiments 1-5: Fission product deposits on clad specimens and their thermal stability.** Blackadder, W.; Forsyth, R.; Malen, K.; Nilsson, Bengt-Aake. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Mar 1978. 36p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This report is the fifth of a group which present the results obtained during the first 5 experiments in the S176 series of irradiation experiments. The aim of this series is to provide informtion on the distribution of fission products in intact irradiated fuel rods, both within the UO_2 fuel and on the inside of the Zircaloy clad. Fuel rods, previously irradiated to appreciable burnups in the Aagesta R3 reactor, after cooling, are re-irradiated in the Studsvik R2 test reactor for short periods to build up significant inventories of short-lived fission products of interest. Examination of sections of fuel and clad is performed within a short time after removal from the reactor.

56593 (STUDSVIK-BL—78-31) **Fuel model studies. Comparison of our present version of GAPCON-THERMAL-2 with results from the EPRI code comparison study. Partial report.** Malen, K.; Jansson, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug 1978. 39p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Runs with our present version of GAPCON-THERMAL-2 have been compared to results from the EPRI code comparison study. Usually also our version of GAPCON predicts high temperatures, 100-300 K or 10-15% higher than average code predictions and experimental results. The well-known temperaturegas release instablility is found also with GAPCON. In this case one identifies the gas release limits 1400 deg C and 1700 deg C as instablility points.

56594 **Effects of stress on swelling in reactor fuel cladding.** Bates, J.F.; Gilbert, E.R. (Hanford Engineering Development Lab., Richland, WA (USA)). pp C4/1 1-8 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this report is to describe the effect of stress on swelling in both annealed and 20% cold worked 316 stainless steel. An effect of stress on swelling in irradiated metals has been postulated for some time. Low fluence data confirmed that indeed a tensile stress can increase swelling in irradiated annealed 316 stainless steel and that the maximum swelling occurs at an intermediate stress level which is approximately equal to the proportional elastic limit of the material. The specimens discussed above were examined by transmission electron microscopy and an effect of stress on the microstructure of the annealed and 20% cold worked 316 specimens has been observed. Howver, as yet, copious swelling had not occurred in the 20% cold worked material. Specimens of 20% cold worked 316 fabricated from the same heat of material as those described above have now been irradiated to sufficiently high neutron fluences that swelling has occurred in both the annealed and cold worked conditions. Swelling increases linearly with stress for both materials. However, for solution annealed 316, swelling reaches a maximum at approximately 136 MPa, whereupon further increases in stress result in reduced swelling. It is felt that this reduction in swelling is related to the onset of plastic yielding in the material. The swelling observed in the 20% CW 316 and the solution annealed 316 below the maximum swelling stress can be adequately described by an equation

of the form: $S = S_0(1 + Psigma)$. No strong effect of stress on changing the incubation period associated with void nucleation was found.

56595 Usefulness of simple theoretical analyses in the modelling of fuel rod behaviour. Smith, E. (Manchester Univ. (UK). Dept. of Metallurgy). pp C0/B 1-12 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Simple theoretical analyses, based on physical reasoning procedures and idealized models, have played a vital role in various branches of structural mechanics, especially those concerned with reactor technology. The classic example is fracture mechanics, whose principles are used extensively in the development of safe operational criteria for nuclear reactor pressure vessels; such an important use of simple theoretical analyses is an object lesson to those concerned with complex engineering situations. The case for the necessity for simple theoretical models, with respect to nuclear reactor fuel rod behaviour, is argued in this paper, the impact of the simple approach on the overall problem being emphasized. The paper provides specific examples to illustrate this general theme.

CONTROL SYSTEMS

56596 (FEI—566) **Experimental-calculation studies on efficiency of europium oxide rods of the BFS-29 assembly.** Gorbatov, N.E.; Matveev, V.I.; Tyutyunnikov, P.L.; Efimenko, E.M.; Efimov, E.F.; Ivanov, A.P.; Melamed, V.E.; Abagyan, L.P.; Zakharova, S.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 17p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Experimental results of measurements of the efficiency of the rods made of natural boron carbide and europium oxide taken on one of the models of the BN-600-reactor - BFS-29 assembly are presented. The experimental data are compared with the results of calculations. It is shown that the experimental data agree (within 10%) with the calculated results. The analysis of the obtained results shows that the efficiency of the identical rods made of natural boron carbide and europium oxide is approximately equal in the fast power reactors, type BN-600.

56597 (HEDL-SA—1698-FP) **In-reactor measurement of neutron absorber performance.** Hollenberg, G.W.; Jackson, J.L.; Basmajian, J.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1978. Contract EY-76-C-14-2170. 29p. (CONF-790602—86). Dep. NTIS, PC A03/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

An instrumented absorber experiment in the Experimental Breeder Reactor-II yielded data on the helium release of boron carbide at exposures up to 53 x 10^{20} neutron captures/cm^3 and temperatures from 766 to 952°C. Helium release results demonstrated a high rate of helium release initially, and a much lower rate in a secondary region. In addition, the experiment demonstrated the effectiveness of vents in releasing gas from a plenum during irradiation.

56598 (IAE—2792) **Methods for analyzing stability of closed control systems with markedly nonlinear characteristics.** Kuz'micheva, V.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 29p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The solutions of dynamic equations of NPPs with WWER type reactors having closed automatic power control systems are analyzed in terms of their stability and asymptotic behaviour. Power relays with pronounced nonlinear characteristics are built-in features of the control system. The algorithm is written in FORTRAN-CERN for a BESM-6 computer. The code is capable of analyzing the stability in terms of the Lyapunov method and the asymptotic behaviour of the solutions up to the 5Oth order.

56599 (IAE—2842) **Interference of neutron-absorbing control rods in a large power fast reactor.** Karpov, V.A.; Matveev, V.I.; Protsenko, A.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 13p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A numerical experiment investigating interference of absorbing rods in a BN-600-type reactor using the BFS-24-16 critical assembly is considered. The experiment was carried out with two-dimensional KENT programm based on the grid solution technique of the two-group diffusion equation in hexagonal geometry. It is shown that in case of the optimum location of rods the gain up to 20% can be obtained in the system effectiveness. Using an example of internal and external rings of the absorbing rods it is shown that the methodical error of pairing interference is equal to 10% of the interference effect.

56600 (IKE—6-116) **Calculation of optimum control rod operation programme for boiling water reactor.** Fehr, L. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Jan 1978. 137p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Thesis.

Control rod operation programmes are calculated based on a three dimensional Boiling Water Reactor situation model. The position of the control rods at variosu burn-ups is chosen by an optimisation so that the sum of the square deviations of the load density distribution from an optimum distribution ('Haling' distribution) are minimised. Other conditions are remaining critical and observing the thermal limits for central fuel element melting and critical heat surface loading. As an example, an optimum control rod operation programme for the first cycle in Lengen nuclear power station is calculated and is compared with the programme actually used. (orig.) 891 HP.

56601 (INIS-mf—4245) **Nuclear Installations Inspectorate criteria for assessing control and instrumentation systems for nuclear power plants.** Petrie, J.L. (UKAEA). 1978. 8p. (CONF-7710184—15). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

The Nuclear Installations Inspectorate is responsible for licensing all civil nuclear power plants in the United Kingdom. The criteria which have been developed within the NII for the assessment of nuclear power plant proposals are described. The philosophy underlying the criteria is outlined and specific criteria are chosen for more detailed discussion.

56602 (INIS-mf—4246) **Safety aspects on the Asea-Atom BWR 75 control room design.** van Gemst, P.; Pedersen, T. (ASEA-ATOM AB, Vaesteraas (Sweden)). 1978. 26p. (CONF-7710184—9). Dep. NTIS (US Sales Only), PC A03/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

The control room is an integrated part of the total plant layout and is located in a special building, known as the control building. The problems of designing a control room meeting all safety requirements and at the same time allowing for modifications to meet special customer specifications are described.

56603 (INIS-mf—4249) **Optimization criteria for control and instrumentation systems in nuclear power plants.** Gonzalez, A.J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Gerencia de Proteccion Radiologica y Seguridad). 1978. 23p. (In Spanish). (CONF-7710184—11). Dep. NTIS (US Sales Only), PC A03/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

The system of dose limitation recently recommended by the International Commission on Radiation Protection includes, as a base for deciding what is reasonably achievable in dose reduction, the optimization of radioprotection systems. This paper, after compiling relevant points in the new system, discusses the application of optimization to control and instrumentation of radioprotection systems in nuclear power plants. Furthermore, an extension of the optimization criterion to nuclear safety systems is also presented and its application to control and instrumentation is discussed; systems including majority logics are particularly scrutinized. Finally, eventual regulatory implications are described.

56604 (INIS-mf—4250) **Problems about the analysis of technical requirements compliance in NPPPCI systems.** Perello, M. (Junta de Energia Nuclear, Madrid (Spain). Seccion de Seguridad Nuclear). 1978. 8p. (CONF-7710184—14). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

The display of the problems that the analysis of the technical requirements compliance bring along is presented. In the project of nuclear power plants, above all, the influence of national and international standards in the analysis of the adjustment of requirements established by the governments of nuclear safety of the different countries. In the oral presentation greater emphasis is made on the difficulties that the PSAR evaluation brings when the lack of technical standards in the owner country makes necessary the use of other countries rules.

56605 (INIS-mf—4251) **Some remarks on software reliability.** Gonzalez Hernando, J.; Sanchez Izquierdo, J. (Junta de Energia Nuclear, Madrid (Spain)). 1978. 17p. (CONF-7710184—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

Trend in modern NPPCI is toward a broad use of programmable elements. Some aspects concerning present status of programmable digital systems reliability are reported. Basic differences between software and hardware concept require a specific approach in all the reliability topics concerning software systems. The software reliability theory was initialy developed upon hardware models analogies. At present this approach is changing and specific models are being developed. The growing use of programmable systems necessitates emphasizing the importance of more adequate regulatory requirements to include this technology in NPPCI.

56606 (INIS-mf—4280, pp 230-233) **Use of control computers in experimental nuclear power facilities.** Mickal, V.; Rygl, J.; Stulik, P. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

The possibility was studied of applying a control computer for existing and projected experimental facilities in the Nuclear Research Institute. It was found that it would be useful to install a computer controlled measuring and control system in two cases, viz.: (a) in experimental facilities with a limited number of measuring and control points and with a continuous experimental programme assuming software-demanding and frequently changing processing of measured data; (b) in newly built high-cost experimental facilities with a considerable number of measuring and control points. The above experiments should be remotely connected to provide that the control computer be rationally used without time losses and that it be prepared for the connection of other remote equipments. The CAMAC system best meets all these requirements. The demands are listed on hardware, software, cost and other factors related to the Institute's conditions for variants (a), (b) and to a system of remote connection incorporating the CAMAC system.

56607 (KURRI-TR—164) **Simulation test for automatic control of two-sectional core reactor using analog computer.** Yamamoto, S. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). Oct 1977. 26p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The high neutron flux reactor being planned as the second reactor in the Research Reactor Institute, Kyoto University, has two-sectional core construction with light water moderation and heavy water reflector. Its constant output control is performed so as to make the neutron flux of each reactor core constant. Each core is provided with an automatic control system. The dynamic characteristics of the two-sectional core were analyzed and treated, using one group two point approximation. The control system of each core is composed of PI controller, Up-down relay, control rod-driving motor and control rod position feedback system. Analog computer simulation was conducted on these control systems, in which the output changes in both cores were observed when stepped reactivity disturbance was given to one core in steady operation. In coupling of approximately 10 to 50 of K/l, the ratio of coupling coefficient K to neutron lifetime l, any problem due to interference between the control systems for both cores seems not to occur. Coupling of approximately 50 of K/l is not sufficient for changing the control systems to one system regarding the reactor cores as single core. Prior to the above testing, experiments for single core were carried out, and the results are described at the end of the paper as the appendix.

56608 (WAPD-TM—1143) **Light Water Breeder Reactor movable fuel hydraulic balancing system (LWBR Development Program).** Bengel, P.R.; Turner, J.R.; Sinderson, S.W. Jr. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Jul 1979. Contract EY-76-C-11-0014. 46p. Dep. NTIS, PC A03/MF A01.

Reactivity control in the Light Water Breeder Reactor (LWBR) is obtained by axial positioning of twelve movable fuel assemblies, which thus serve the dual purpose of contributing to reactor power and functioning as neutron economic control elements. A hydraulic technique is used to automatically counterbalance the upward hydraulic force of these elements. Hydraulic balancing is accomplished using the Bypass Inlet Flow (BIF) balancing system, which utilizes the core coolant inlet pressure to develop a downward hydraulic force on the control elements of equal magnitude to the upward hydraulic force caused by axial flow of coolant through the movable control elements. Thus the net force acting on each control element is approximately equal to the weight of the element and acts in a downward direction at all coolant flow rates. This net force adequately accelerates the control element to satisfy automatic insertion requirements. The BIF system also provides for limiting the velocity of downward motion and for decelerating the fuel assembly at the bottom of its stroke. The logic underlying the selection of the BIF system as the appropriate component of the Reactivity Control System to provide control element insertion integrity is discussed, the components comprising the control elements and the BIF piping network used in the Light Water Breeder Reactor are described, and a discussion of the BIF system operation is presented. Descriptions of full-scale hydraulic testing resulting in qualification of the analytical model, and of useful supplementary information acquired from BIF system hydraulic testing are also included as appendices.

56609 **Thermal-stress analysis of HTGR fuel and control rod fuel blocks in in-block carbonization and annealing furnace.** Gwaltney, R.C.; McAfee, W.J. (Oak Ridge National Lab., TN (USA)). pp D5/5 1-12 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this study was to provide scoping type calculations, estimates of the general magnitudes of internal stresses and strains induced by the temperatures and thermal gradients imposed on HTGR fuel and rod fuel blocks as they pass through the heated zone of an in-block carbonization and annealing furnace. This furnace, a development model, is to be used for insitu carbonization and annealing of reprocessed 'green' fuel rods in the fuel holes of HTGR fuel and control rod fuel blocks. The calculated results were used as a basis for assessing the potential for crack generation in the graphite matrix of the blocks. A new model for performing thermal stress analyses in structures with multiple penetrations was applied to these analyses. This method couples the development of an equivalent thermal conductivity for the blocks, a technique that has been used extensively for modeling the thermal characteristic of reactor cores, with the use of the equivalent solid plate method for stress analysis.

ENVIRONMENTAL ASPECTS

SITING

56610 (INIS-mf—4351) **Possible sites for atomic power stations east of the Great Belt. Report from the working group on the siting of atomic power stations set up by the Ministry of the Environment.** (Miljoeministeriet, Copenhagen (Denmark)). May 1978. 31p. (In Danish). Dep. NTIS (US Sales Only), PC A03/MF A01.

A report by the working group set up by the Danish Ministry of the Environment to deal with the siting of nuclear power stations. It deals with the possible siting of nuclear power stations east of the Great Belt, and considers 19 possible areas in detail. Factors such as: population structure, urban expansion, preservation of nature, cooling water, proximity of airfields, and the possibility of district heating from a power station on the site are taken into consideration. The working group recommends that steps should be taken to secure 6 areas for the possible siting of nuclear power stations east of the Great Belt.

56611 (Juel-Spez—12) **Contribution to the standardization of nuclear power plant siting.** Hensel, W. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; Essen Univ. (Gesamthochschule) (Germany, F.R.)). Jun 1978. 135p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Diss.

A planning instrument has been developed, with the help of which a test can be made to determine which local and regional sites in the Federal Republic of Germany are still available, after applying a number of siting criteria. Among others, some safety criteria of the Minister of the Interior (Bundesminister des Innern) and some energy management criteria of the Minister for Economic Affairs (Bundesminister fuer Wirtschaft) are put into practice. The regional data bank system presented enables a stepwise process of selection to be carried out. For this, the area of the Federal Republic of Germany is covered by a grid of some 248,000 squares, each of size 1 km x 1 km. The elements of the grid are interrogated according to a number of criteria. As a result, area totals are generated during the course of the selection process. At the same time the position of favourable grid elements is displayed on maps of the Federal Republic of Germany.

RADIOACTIVE EFFLUENTS

56612 (UCID—18243) **Archiving the paper fallout from Three Mile Island.** Fisher, H.L.; Caswell, V.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Aug 1979. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A02/MF A01.

During the Three Mile Island incident, the Atmospheric Release Advisory Capability (ARAC) Center at the Lawrence Livermore Laboratory supplied a continuous flow of meteorological and radioactive plume transport and diffusion data to agencies of the Department of Energy and Nuclear Regulatory Commission from March 28 to April 18, 1979. By then a vast amount of data had

accumulated in the ARAC Center. This paper describes the scheme devised for archiving this material and suggests how it might be extrapolated to archive responses to future incidents of a more complex nature or longer duration.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 57127

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 56431, 56607, 56632, 56641, 56648, 56653, 56660, 56922, 57115

56613 (CONF-790802—71) **Thermal-hydraulic and structural safety analysis of SLSF P3 experiment.** Ragland, W.A.; Ariman, T.; Tessier, J.H. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The Sodium Loop Safety Facility (SLSF) P3 experiment was the fourth in a series of in-reactor tests in the Engineering Test Reactor and simulated an unprotected flow coastdown in a 37 pin bundle. A comprehensive thermal-hydraulic analysis of the SLSF loop was coupled with a structural analysis of the test section hexcan outer duct in order to provide assurance, before the transient, that the loop would safely contain the P3 experiment. This analysis was performed for both the expected transient and for an off-normal condition of failure of redundant logic circuits to provide the proper pump power demand signal. Results of the analysis showed the hexcan outer duct to safely contain the P3 experiment for both conditions. The analysis for the expected transient has been verified by the successful completion of the P3 experiment.

56614 (FEI—786) **Fast neutron attenuation in reactor reflector material.** Bykovskii, V.S.; Koloskov, N.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 11p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Radial distributions of fast neutrons in aluminium, stainless steel, beryllium and water reflectors have been experimentally investigated. The experiments are conducted using a critical assembly consisting of one or three sections of a sectional type research and test reactor. The measurements have been carried out with ^{237}Np fission chambers in cadmium sheath. Presented are basic parameters of the assemblies, experimental and calculated neutron relaxation lengths. The calculations are performed in terms of the Psub(I)-approximation using a one-dimensional 18-group code. The measurements have proved the additivity property of neutron fluences from several sources. The experimental lengths weakly depend on the core height and are in a good agreement with the calculated ones for the reflector materials.

56615 (HEDL-SA—1873) **Recent developments in LOFT advanced fuel rod instrumentation.** Sheen, E.M.; Billeter, T.R.; Cannon, C.P.; Chan, A.I.Y.; Stringer, J.L. (Hanford Engineering Development Lab., Richland, WA (USA)). 17 Jul 1979. Contract EY-76-C-14-2170. 45p. Dep. NTIS, PC A03/MF A01.

Progress is reported in the areas of fuel centerline temperature measurement, fuel rod pressure measurement, fuel rod axial motion, and upper plenum gas temperature measurement.

56616 (INIS-mf—4280, pp 221-223) **Reactor water loops developed to study the water regime of the WWER primary circuit.** Fric, Z.; Rypar, V.; Zajic, V.; Masarik, V. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

The water regime in the WWER reactor primary coolant circuit is studied using the RVS-2 water reactor loop which allows the attainment of 6.5 MPa and 200 degC. The loop is made of 18Cr8Ni stainless steel and consists of several special-purpose circuits. The main circuit is equipped with a 30 x 3 mm piping and comprises the active and reference channels. The active channel may be disconnected from the rest of the system by closing valves. Some 25 variables are monitored in operation, such as temperature, pressure, flow rate, level, radiation level, electric currents, etc., a number of them being automatically controlled. Radiation-exposed specimens are investigated in a hot chamber. For modelling the WWER-1000 conditions, the RVS-3 water reactor loop was designed which will allow the attainment of coolant parameters of 350 degC and 20 MPa. In the meantime, the RVS-4 small loop (0.6 MPa and 100 degC) is used for preliminary radiation chemistry tests.

56617 (INIS-mf—4280, pp 24-36) **Reconstruction of the WWR-S reactor. I. Switch-over to IRTM fuel.** Kavan, L.; Listik, E.; Musilek, F.; Pittermann, P.; Slechta, M.; Vojta, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

The findings are briefly reviewed gained in the first stage of the WWR-S reactor reconstruction aimed at achieving a thermal output of 1O MW. The principle of the reconstruction consists in the use of a new type of fuel, IRT-M, in place of EK-10 used so far. The new fuel assembly consists of four fuel elements in the shape of rectangular cross-section concentric tubes having a wall thickness of 2 mm, the kernel consists of a uranium-aluminium alloy with 80% U 235 enrichment. With this type of fuel, the reactor core has high reactivity excess in spite of a relatively small number of fuel assemblies used (26 pcs) and may operate at high thermal load, which permits obtaining high neutron flux, i.e., 10^{14} n/cm^{2}s for thermal neutrons. The number of regulating rods has been increased from 9 to 12, the reactor control and protection system has been entirely reconstructed and other necessary adaptations of the core have been made.

56618 (INIS-mf—4470, pp vp) **Mechanical response of FFTF reference and P1 cladding tubes under transient heating.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56619 (JAERI-M—7554) **Quarterly progress report on the NSRR experiments. V. July to December 1977.** Ishikawa, M.; Tomii, K.; Hoshi, T.; Onishi, N.; Saito, S. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 169p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

Studies of fuel behavior under simulated Reactivity Initiated Accident (RIA) conditions in NSRR have proceeded since October 1975. The results from July to December 1977 are described at the following tests: standard fuel, pre-pressurized rod, gap parameter, flow area simulation, rod bundle, waterlogged rod, stainless-steel-cladding rod, fretting-corroded rod.

56620 (JAERI-M—7617) **Modification of the heavy-water tank seal and reactor top shield in JRR-2.** Banba, M.; Miyasaka, Y.; Yamaguchi, S.; Shimizu, K. (Japan Atomic Energy Research Inst., Tokyo). May 1978. 145p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

This report describes installation of a standing seal by welding to stop heavy water leakage in heavy-water tank and replacement of the reactor top shield, in research reactor jRR-2 (heavy water moderated and cooled, 10 MW thermal, and 2 x 10^{14} n/cm^2 sec peak thermal neutron flux). The puspose was to eliminate reactor operational problems, lower shielding plug corrosion and heavy water leakage and also to reduce tritium release and to improve vertical experimental facilities. Works were started in January 1974 following out-pile mock-up tests, and completed in September 1975. Radioactivities around the work area due to 13 years reactor operation were tritium concentration about 900 μCi/cm^3 in the heavy water and maximum surface dose rate about 5 R/h near the welding work area. Personnel exposure was strictly controlled with shielding and protective equipment to attain maximum personal safety. Maximum and average exposure dose rates were 230 mrem/man and 83 mrem/man respectively, which are about one half of the planned levels. Modifications were satisfactory in view of 5,000 hours reactor operation and the functional test results. The schedule, out-pile-tests, removal of radioactive components, installation works, functional tests and operation results, which are described, should be significant for future references.

56621 (JAERI-M—7632) **Study of the modifications of nuclear instrumentation systems for JRR-2.** Azim, M.; Horiki, O.; Sato, M. (Japan Atomic Energy Research Inst., Tokyo). Apr 1978. 73p. Dep. NTIS (US Sales Only), PC A05/MF A01.

In this report a comparative study has been carried out between the original A.M.F. design and the modified design for the nuclear instrumentation systems of the Research Reactor JRR-2, at the Tokai Research Establishment of JAERI. Due to a fire accident in the control room, in July 1968, the originally designed nuclear instrumentation systems, using conventional vacuum tube circuits, were destroyed and were replaced by the modified design, incorporating solid state linear integrated circuits as basic circuit components. The results of the reactor instrumentation systems modification at JRR-2 are very encouraging as the operating efficiency of the Reactor registered an improvement of 43%. Moreover the safety aspects have been fully taken care of in the new design and the reactor is well guarded against all possible instrument failures and human errors. This report presents the basic theory of operation of the two designs alongwith a comparative safety analysis.

56622 (Juel—1480) **Development, construction, and operation of a rig irradiation facility for vertical experiments in the reactor FRJ-1 (MERLIN).** Kuepper, H.; Butzek, D.A.; Vieth, J.; Schmidt, F.;

Bertram, W. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Allgemeine Technologie). Jan 1978. 47p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

After a detailed description of the irradiation facility, its setup and thermal design, the test operation and some preliminary experiments are reported. For the rig an additional electric heating and a sodium capsule were newly developed. The arrangement, having been essentially inproved (in the course of development of the in-core thermionic reactor) as compared with earlier designs, allows the simultaneous operation of 2 rigs with the pertinent measuring, control and safety systems. Installation within the reactor and operation of the irradiation facility are described in detail. (UA) 891 UA.

56623 (KIYI—77-14) **Neutron flux dependence on the fuel concentration in fuel elements of the WWR-M-Kiev reactor core.** Ozimai, N.S.; Sumets, N.C. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1977. 19p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The flux density space distribution of the thermal neutrons and neutrons with E > Esub(eff) ^{232}Th was measured for different fuel distributions in the reactor core radius by the KNT-4 fission chamber. The flux density of the thermal neutrons and neutrons with E > Esub(eff) ^{232}Th was also measured in the reactor core center at the constant fuel concentration. The maximum of the fast neutron flux density is found to be in approximately 20% burnup zone. The optimum reloading of the reactor core is recommended to create the maximum flux of thermal and fast neutrons on the WWR-M reactor core boundary.

56624 (NIIAR-P—26(320)) **Criteria for efficiency evaluation of multiloop reactor utilization for engineering research.** Tsykanov, V.A.; Kuprienko, V.A. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 20p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Considered are the peculiar features of the loop reactors used for operation of the new types of the fuel assemblies within their entire service life. Suggested is the procedure for estimation of the economic efficiency of the loop reactors, which takes into account the peculiar features of the loop reactors, provides for practical analysis of the reactor operating conditions, and makes it possible to perform project estimation of the technical and economical characteristics of the designed system. The definitions for two criteria are suggested: productivity of the loop reactor and average cost of the performed experiments. Relationship between these criteria and operating parameters of the reactor is analyzed. Considered are various regimes of fuel recharging in the core, it is shown that optimum fuel burning takes place in the fuel assemblies under partial recharging conditions. The problem on the expedient number of the loop channels in the reactor core is discussed.

56625 (PTB-FMRB—73) **Report on work on the Forschungs- und Messreaktor Braunschweig (FMRB) for the year 1977.** Kriks, H.J.; Vorbrugg, W. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Forschungs- und Messreaktor). Jul 1978. 18p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In 1977 the Forschungs- und Messreaktor Braunschweig (FMRB) has been in action for 3289 hours without any serious disturbance. The experience in the reactor operation, in the radiation protection work as well as in the experiments at the beam tubes is reported. (orig.) 891 UA.

56626 (STUDSVIK-MC—78/277) **Analysis of fission products in the cooling water system of the R2-reactor after fuel element failure. 3. Fuel element failure under the period of Aug 1977 to Apr 1978.** Aagaard, P. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug 1978. 25p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Water samples from 14 fuelelement failure events have been analyzed. The leaking varies a lot, quantitatively and qualitatively. The measurements are presented in 14 tables.

56627 **Influence of the statistical scatter of both the geometry parameters and the coating strength on the failure rate of coated fuel particles.** Bougartz, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). pp C1/7 1-11 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An HTR fuel particle consists of a spherical pyrocarbon (PyC) and siliconcarbide (SiC) coated fuel kernel. The kernel diameter and the thickness of the adjacent buffer coating layer, a very porous PyC which provides free volume for the fission gases, have a significant influence on the stresses generated by the fission gas in the outer coating layers, which may consist of two dense PyC layers with a SiC interlayer. The study was performed for particles with a SiC interlayer. Here the whole fission gas pressure acts on the SiC as its Young's modulus is about ten times higher than that of the two dense PyC layers. This stress is reduced by the irradiation induced shrinkage and creep of the two dense PyC layers. The kernel diameter and buffer thickness have a scatter which is determined by the fabrication process, for this scatter a Gaussian distribution was assumed, the mean values and standard deviations were measured. The SiC strength shows an additional material inherent scatter for which a Weibull distribution was assumed. Its mean value and Weibull parameter were measured. It can be shown that the influence of the scatter in the geometry parameters on the mean value of the SiC strength may be neglected. Stress model calculations were performed systematically for various buffer thickness and kernel diameter combinations at different burn-ups. Using the calculated stresses and the distributions of these two parameters it is possible to calculate the stress distributions over the particles at the corresponding burn-ups. Taking into account the strength distribution of the SiC, the fraction of particles expected to break was then determined as a function of burn-up.

56628 **Development of a (U,Zr)C-graphite pulsed reactor fuel element.** Reuscher, J.A.; Karnes, C.H.; Marion, R.H. (Sandia Labs., Albuquerque, NM (USA)). pp D5/8 1-8 of Structural mechanics in reactor technology. Vol. D. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new core is being designed to improve the performance of the Annular Core Pulse Reactor (ACPR). A program has been conducted to develop a high-enthalpy fuel element using a graphite matrix fuel containing (U-Zr)C solid solution particles. Since the (U,Zr)C-graphite fuel is subjected to a reactor period of two milliseconds with a large temperature gradient across the fuel diameter, fracture due to thermal stresses is the primary failure mode. The development program optimized this class of fuel for pulsed reactor application. The program has successfully developed a (U,Zr)C-graphite fuel element with a high volumetric enthalpy which can be used in a water cooled pulse reactor. Extensive tests have demonstrated the feasibility and safety of the fuel element design.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

56629 (NUREG/CR—0952) **Conceptual design of a uranyl nitrate fueled reactor for the destructive testing of liquid metal fast breeder reactor fuel subassemblies.** Ramsower, S.E. (Arizona Univ., Tucson (USA). Dept. of Nuclear Engineering). Aug 1979. 87p. NTIS.

A preliminary design of a uranyl nitrate test reactor is developed, with emphasis placed on the core neutronics and cross section development. ENDF/B-IV cross section data and the AMPX system were used to develop a 25 group neutron cross section library. A series of one-dimensional transport calculations were made in order to arrive at a reference design. Power densities of 16.5 Kw/l appear to be attainable in the 217 pin FFTF test subassembly, with a peak neutron flux in the test zone of 2.4 x 10^{14} n/cm^2-sec. Other engineering features pertinent to the overall system design are discussed, including: (1) corrosion, (2) treatment of radiolytic gas, (3) heat removal, and (4) reactor control.

PROPULSION REACTORS

56630 (AD-A—061748) **Design study of a two-phase turbine engine for submarine propulsion. Final report, 1 July 1977-31 May 1978.** Ritzi, E.; Hays, L. (Biphase Energy Systems, Santa Monica, CA (USA)). 18 Aug 1978. Contract N00014-77-C-0545. 179p. NTIS PC A09/MF A01.

A design study of the Biphase turbine engine for underwater propulsion was performed, using a nuclear reactor heat source. A single stage oil/steam turbine without and with gear reduction was designed for 15000 hp at 180 rpm and 1000 rpm respectively. Another Biphase engine which uses steam and water alone was analyzed designed. Significant performance advantages over conventional steam engines were found, especially at cruise conditions (part load) together with significant weight and space savings. A design method for direct contact heat exchangers of the spray type was developed. (Author)

REACTOR SAFETY

REFER ALSO TO CITATION(S) 57115

56631 (AEEW-R—1196) **RELAP-UK MK 4 transient thermal-hydraulic code summary and input data description.** Brittain, I.; Bryce,

W.; Green, C. (UKAEA, Winfrith. Atomic Energy Establishment). Aug 1978. 65p. Dep. NTIS (US Sales Only), PC A03/MF A01.

RELAP-UK MK IV is the latest UK code in the RELAP series of transient thermal-hydraulic codes for water reactor safety and fault analysis. It is the first version with full capability for PWR blowdown. The major improvements over earlier versions are a drift flux model, the Bryce flow-dependent slip correlation, a revised bubble rise model and a generalised 'heat slab' option. Other developments include a simple rewetting model, Fanning friction factor and change of area pressure drop models, time-dependent boundary nodes and an option to input pump speed history. RELAP-UK MK IV is available on the Harwell IBM 370-168 computer.

56632 (ANL—78-89) **Final safety analysis addendum to hazard summary report, experimental breeder reactor No. II (EBR-II): the EBR-II cover-gas cleanup system.** Fryer, R.M.; Monson, L.R.; Price, C.C.; Hooker, D.W. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 91p. AT.

This report evaluates abnormal and accident conditions postulated for the EBR-II cover-gas cleanup system (CGCS). Major considerations include loss of CGCS function with a high level of cover-gas activity, loss of the liquid-nitrogen coolant required for removing fission products from the cover gas, contamination of the cover gas from sources other than the reactor, and loss of system pressure boundary. Calculated exposures resulting from the maximum hypothetical accident (MHA) are less than 2% of the 25-Rem limit stipulated in U.S. Regulation 10 CFR 100; i.e., a person standing at any point on an exclusion boundary (area radius of 600 m) for 2 h following onset of the postulated release would receive less than 0.45 Rem whole-body dose. The on-site whole-body dose (10 m from the source) would be less than 16 Rem.

56633 (ANL—79-73) **Multichannel clad-relocation model for fast-reactor loss-of-flow accidents.** Ishii, M.; Chen, W.L.; Grolmes, M.A. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 62p. Dep. NTIS, PC A04/MF A01.

During an unprotected undercooling accident in a liquid-metal fast breeder reactor, the motion and relocation of the molten cladding can be important because of its potentially significant effect on reactivity, blockage formation, and subsequent fuel motion. The present study analyzes the clad relocation problem based on a multichannel film-flow model. The important aspects considered in the analysis are the non-uniform transverse clad-melting pattern and diversions of sodium-vapor flow within a subassembly. It has been shown that the motion of molten clad and subsequent blockage formations can be significantly influenced by this interconnected channel effect. Several sample calculations have been made in order to demonstrate these points.

56634 (ANL-AFP—63) **Advanced fuels development program. Quarterly progress report, October-December 1978.** Kittel, J.H. (comp.). (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 248p. AT.

Progress is summarized in the following LMFBR mixed carbide and mixed nitride fuel development tasks: (1) steady-state irradiation performance; (2) transient irradiation performance; (3) fabrication; (4) design and modelling; (5) fuel properties; (6) safety; and (7) environmental assessment.

56635 (ANL-CT—79-47) **Preliminary study of fluid effects on reactor core seismic response.** Batill, S.M. (Argonne National Lab., IL (USA)). Jul 1979. Contract W-31-109-ENG-38. 34p. AT.

The dynamic response during a seismic event of a liquid metal fast breeder reactor core may be influenced significantly by the fluid contained between the fuel assemblies. This report documents a preliminary study designed to highlight the dominant fluid effects on the dynamic response of a related idealized model. The model consists of a simple two-dimensional rectangular channel which contains five rigid blocks with square cross-sections. Fluid added mass and damping coefficients were calculated using a finite element model of the fluid region. These effects were incorporated into the SCRAP computer code and position-time histories due to simple harmonic base motion were calculated for the idealized core.

56636 (BNL-NUREG—25846) **Stability analysis and response characteristics of two-degree of freedom nonlinear systems.** Subudhi, M.; Curreri, J.R. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 5p. (CONF-7810154—2). Dep. NTIS, PC A02/MF A01.

From 49. shock and vibration symposium; Washington, DC, USA (17 Oct 1978).

Understanding the behavior of nonlinear systems is important in laboratory testing. Sine sweep-up and sweep-down tests are routinely done to reveal all of the stable roots in this type of system. There are, however, certain types of softening-hardening restoring force characteristics for which sine sweep testing, whether up or down, will not reveal all of the stable roots. In such cases, it is important that the stable roots be identified so that proper testing procedures are used and the test results are correctly evaluated. The stability of a nonlinear two degree-of-freedom spring-mass system subjected to a sinusoidal exciting force is examined. The solution is perturbed to arrive at a set of coupled variational linear differential equations with periodic coefficients. Floquet theory is used to obtain a characteristic equation. The Routh-Hurwitz stability criterion is adopted to study the stable and unstable regions of the response curves. A computer program is developed to carry out the entire analysis. Extensive information regarding stable zones of the system response is described by means of nondimensional frequency-amplitude diagrams. The results are examined in terms of inferring dynamic response characteristics for sine sweep tests.

56637 (BNL-NUREG—26464) **Inception and development of voids in flashing liquids.** Jones, O.C. Jr. (Brookhaven National Lab., Upton, NY (USA)). Jun 1979. Contract EY-76-C-02-0016. 40p. (CONF-790760—1). Dep. NTIS, PC A03/MF A01.

From US/Japan seminar on two-phase flow dynamics; Tokyo, Japan (23 Jul 1979).

Recent work aimed at correctly describing nonequilibrium vapor generation rates in flashing liquids in decompressing flows similar to those which might be encountered in a loss of coolant accident in a nuclear reactor is summarized. Analysis is reviewed which describes the flashing inception superheat in terms of the turbulence intensity for a given expansion rate and initial temperature, and interfacial area density and interfacial heat flux, and the volumetric vapor generation rates. Comparisons with existing data are included and further experiments being undertaken are described, including typical recent results.

56638 (CAAP-TR—055) **Code assessment and applications program: audit calculations of small cold leg breaks in a Combustion Engineering pressurized water reactor.** Davis, C.B. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 43p. Dep. NTIS, PC A03/MF A01.

Audit calculations were performed for the Nuclear Regulatory Commission. Three transients initiated by small breaks in the cold leg piping of a Combustion Engineering pressurized water reactor were analyzed using the RELAP4/MOD7 computer code.

56639 (CAAP-TR—056) **Code assessment and applications program: RELAP4/MOD6 data comparison for TLTA Test 6406, Run 1.** Ross E.E. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 41p. Dep. NTIS, PC A03/MF A01.

A RELAP4/MOD6 data comparison has been performed for the Two-Loop Test Apparatus Test 6406, Run 1. The study was conducted as part of the Idaho Engineering Laboratory continuing technical support to the Nuclear Regulatory Commission for Industry Cooperative Programs. Conclusions concerning the capabilities of the code are made. Recommendations for improvements in the experimental program and the code are given.

56640 (CEA-CONF—4194) **Study of the HTGR fission product migration at the Osiris experimental reactor.** L'Homme, A.; Lucot, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 1977. 12p. (In French). (CONF-771189—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Symposium on the future of research reactors; Grenoble, France (Nov 1977).

A program of study on accidents in HTR reactor operation is presented: blowdown of primary coolant circuit, water inlet into the primary circuit, fuel element overheating by pipe logging or loss of cooling. These studies will be made in Aida irradiation loop in the pool of the Osiris reactor.

56641 (CEA-CONF—4195) **Utilization of the research reactors for the power reactor control instrumentation development.** Duchene, J.; Verdant, R.; Gilbert, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 1977. 5p. (In French). (CONF-771189—4). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Symposium on the future of research reactors; Grenoble, France (Nov 1977).

Studies on characteristics and reliability of control instruments lead to testing with various radiations of various intensities and energy spectra. Osiris and Triton reactors present this great variety of radiations and a flexibility of use better than power reactors.

56642 (CONF-790802—49) **Comparison of transient PCRV model test results with analysis.** Marchertas, A.H.; Belytschko, T.B. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 19p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

Comparisons are made of transient data derived from simple models of a reactor containment vessel with analytical solutions. This effort is a part of the ongoing process of development and testing of the DYNAPCON computer code. The test results used in

these comparisons were obtained from scaled models of the British sodium cooled fast breeder program. The test structure is a scaled model of a cylindrically shaped reactor containment vessel made of concrete. This concrete vessel is prestressed axially by holddown bolts spanning the top and bottom slabs along the cylindrical walls, and is also prestressed circumferentially by a number of cables wrapped around the vessel. For test purposes this containment vessel is partially filled with water, which comes in direct contact with the vessel walls. The explosive charge is immersed in the pool of water and is centrally suspended from the top of the vessel. The load history was obtained from an ICECO analysis, using the equations of state for the source and the water. A detailed check of this solution was made to assure that the derived loading did provide the correct input. The DYNAPCON code was then used for the analysis of the prestressed concrete containment model. This analysis required the simulation of prestressing and the response of the model to the applied transient load. The calculations correctly predict the magnitudes of displacements of the PCRV model. In addition, the displacement time histories obtained from the calculations reproduce the general features of the experimental records: the period elongation and amplitude increase as compared to an elastic solution, and also the absence of permanent displacement. However, the period still underestimates the experiment, while the amplitude is generally somewhat large.

56643 (CONF-790802—50) **Dynamic response of cracked hexagonal subassembly ducts.** Glazik, J.L.; Petroski, H.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The hexagonal subassembly ducts (hexcans) of current Liquid Metal Fast Breeder Reactor (LMFBR) designs are typically made of 20% coldworked Type 316 stainless steel. Prolonged exposure of this initially tough and ductile material to a fast neutron flux at high temperatures can result in severe embrittlement. Under these conditions, the unstable crack propagation of flaws, which may have been introduced during fabrication or transportation of the hexcans, is a problem of interest in LMFBR safety analysis. The abnormal overpressurization resulting from certain interactions within a subassembly, or the rupture of one or more fuel pins, may be sufficient to overload an otherwise subcritical crack in an embrittled hexcan. This paper examines the dynamic elastic response of flawed and unflawed fast reactor subassembly ducts. A plane-strain finite element analysis was performed for ducts containing internal corner cracks, as well as external midflat cracks. Two worst case loading situations were considered: rapid uniform internal pressurization and suddenly applied point loads at opposite midflats. The finite-element code CHILES, which can accomodate the stress singularities that occur at crack tips, was given dynamic capabilities through the inclusion of a consistent mass matrix and step-by-step time integration scheme. The SAP IV code was also employed for eigenvalue analysis and modal response. Although this code does not contain singular elements in its element library, dynamic stress intensity factors were calculated by a technique requiring only ordinary isoparametric quadrilaterals.

56644 (CONF-790802—52) **Three-dimensional finite-element computations of the transient response of components typical of a reactor structure.** Ash, J.E.; Kulak, R.F.; Marchertas, A.H. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A structural analysis, finite-element code SADCAT has been developed to compute the elastoplastic response of thin-walled structural members undergoing rapid, large displacements in three-dimensional space. A convected-coordinate technique permits a simplified description of large displacements and rotations. The computational procedure consists of a lumped-mass, explicit numerical scheme suited to the nonlinear path-dependent material behavior. Code predictions have been compared with analytical calculations and published experimental data, and the correlations validate the capability of the code to provide reliable predictions for three-dimensional shell-type structure.

56645 (CONF-790802—53) **Eulerian formulation of fluid-structure interaction in reactor containment system.** Wang, C.Y. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

This paper is concerned with an Eulerian formulation for a fluid-structure interface developed for the nonlinear fluid-structure interaction analysis encountered in the primary containment and piping components of nuclear reactors. The Eulerian finite difference methodology is chosen because of its decisive abilities in: (1) investigating material motion with large distortions, (2) treating fluid flow around internal structures having a geometrical discontinuity, (3) handling wave transients in the vicinity of perforated structures. The ultimate objective is to perform the analysis of the reactor integrity when subject to the transient load. Two types of irregular cells are considered and their formulation corresponding to the ICE technique are described. The first one is for interfaces between a coolant and a deformable structure, where the fluid slides tangentially along the moving boundary. A relaxation equation is derived here, allowing the adjustment of the pressure on the moving boundary of the fluid by an amount proportional to the actual mass flux across the boundary. The second irregular cell is for fluid adjacent to the perforated structure where fluid flow through coolant passage takes place. A modified Poisson equation is obtained to appropriately account for the volume perforation and the flow-area availability of the perforated structure. These two equations, in conjunction with the governing Poisson equation of the ICE technique, are solved iteratively. Convergence is attained when boundary conditions at all interfaces are satisified. The development scheme enables the implicit Eulerian hydrodynamic techniques to be coupled with any structural dynamic program. Presently, a corotational coordinate finite element program, WHAMS, is employed for calculating the structural response. Three sample problems are presented to illustrate the analysis. The results are discussed.

56646 (CONF-790802—54) **ALICE: an arbitrary Lagrangian-Eulerian code for analyzing FBR containment response to HCDA.** Chu, H.Y. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

This paper describes a reactor containment code, ALICE (Arbitrary Lagrangian-Eulerian Implicit-Explicit Containment Excursion code), which uses a hybrid Lagrangian-Eulerian finite-difference method for the treatment of the coolant motions and a Lagrangian finite-element technique for the analysis of the containment vessel and other solid media inside a reactor containment. The advantages of the ALICE code over the conventional Lagrangian or Eulerian method are: (1) the interpolations of the fluid and structural motions can be made very accurate as the cell vertices of the fluid adjacent to the structure moving with the structural nodal points; (2) the cells for the fluid calculation can be made in any quadrilateral shape corresponding to the perforated passageways or the structural deformation to avoid irregular-cell calculations; (3) inlet and outlet boundary conditions can be easily treated; (4) long-duration calculations can be achieved by rezoning the large distortion regions; and (5) a pure Lagrangian approach can be applied to those small distortion regions to treat flow problems with many materials. Two examples are given to illustrate the application of the ALICE code. The first one is a shock tube test in which an initial discontinuity of pressure and density is calculated. The second one is a SRI flexible-vessel test specially designed for the containment code validation. Results are discussed in detail.

56647 (CONF-790802—55) **Evaluation of Lagrangian, Eulerian, and arbitrary Lagrangian-Eulerian methods for fluid-structure interaction problems in HCDA analysis.** Chang, Y.W.; Chu, H.Y.; Gvildys, J.; Wang, C.Y. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The analysis of fluid-structure interaction involves the calculation of both fluid transient and structure dynamics. In the structural analysis, Lagrangian meshes have been used exclusively, whereas for the fluid transient, Lagrangian, Eulerian, and arbitrary Lagrangian-Eulerian (quasi-Eulerian) meshes have been used. This paper performs an evaluation on these three types of meshes. The emphasis is placed on the applicability of the method in analyzing fluid-structure interaction problems in HCDA analysis.

56648 (CONF-790802—61) **Coupled hydrodynamic-structural analysis of an integral flowing sodium test loop in the TREAT reactor.** Zeuch, W.R.; A-Moneim, M.T. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A hydrodynamic-structural response analysis of the Mark-IICB loop was performed for the TREAT (Transient Reactor Test Facility) test AX-1. Test AX-1 is intended to provide information concerning the potential for a vapor explosion in an advanced-fueled LMFBR. The test will be conducted in TREAT with unirradiated uranium-carbide fuel pins in the Mark-IICB integral flowing sodium loop. Our analysis addressed the ability of the experimental hardware to maintain its containment integrity during the reference accident postulated for the test. Based on a thermal-hydraulics analysis and assumptions for fuel-coolant interaction in the test section, a pressure pulse of 144 MPa maximum pressure and pulse width of 1.32 ms has been calculated as the reference accident. The response of the test loop to the pressure transient was obtained with the ICEPEL and STRAW codes. Modelling of the test section was

completed with STRAW and the remainder of the loop was modelled by ICEPEL.

56649 (CONF-790802—62) **Thermohydraulic and thermal stress aspects of a porous blockage in an LMFBR fuel assembly.** Kuzay, T.M.; Marr, W.W.; Helenberg, H.W.; Ariman, T.; Wilson, R.E.; Pedersen, D.R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The current safety scenarios of Liquid Metal Fast Breeder Reactors (LMFBR) under local fault propagation include the study of a hypothetical accident initiated by the formation of an external debris porous blockage in a fuel subassembly. In this preliminary experimental and analytical investigation, a non-heat-generating porous blockage was postulated to cover 18 flow channels of a 37 pin Fast Test Reactor (FTR) type fuel subassembly. The axial extent of the blockage is 50 mm. The blockage material is stainless steel (SS 316) with 30 percent average porosity (percent void volume). The blockage and the pins were modeled with a finite element technique and the thermal field in the blockage was predicted. This thermal field was utilized to do a planar thermal stress analysis of the postulated blockage. To verify the analytical model and also to better understand the thermal-hydraulics of such a porous blockage out-of-pile tests were conducted in a sodium loop. Data from the out-of-pile tests was utilized to calibrate and improve the analytical model.

56650 (CONF-790802—63) **Study of structural attachments of a pool type LMFBR vessel through seismic analysis of a simplified three dimensional finite element model.** Ahmed, H.; Ma, D. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A simplified three dimensional finite element model of a pool type LMFBR in conjunction with the computer program ANSYS is developed and scoping results of seismic analysis are produced. Through this study various structural attachments of a pool type LMFBR like the reactor vessel skirt support, the pump support and reactor shell-support structure interfaces are studied. This study also provides some useful results on equivalent viscous damping approach and some improvements to the treatment of equivalent viscous damping are recommended. This study also sets forth pertinent guidelines for detailed three dimensional finite element seismic analysis of pool type LMFBR.

56651 (CONF-790802—65) **Three-dimensional finite element formulation for fluid-structure interaction.** Kulak, R.F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

The safety evaluation of fast reactors often involves the modeling of various types of structural components which interact with surrounding fluid in three-dimensional space. In this paper, several key areas for performing three-dimensional fluid-structure interaction calculations are discussed. A new development is presented for a three-dimensional hexahedral hydrodynamic finite-element based upon a Quasi-Eulerian approach. By using trilinear shape functions and assuming a constant pressure field within the element, simple relations are obtained for internal nodal forces. The forms developed are easily coded and computationally efficient. Because the formulation is based upon a rate approach it is applicable to problems involving large displacements. Only adiabatic processes are considered. The difficult tasks (1) of input data preparation and checking and (2) the displaying of computed results are discussed. The use of automatic mesh generators, input data error analysis, and graphical display of the finite element meshes used to model reactor components are shown to ease the input task. In the final section, the formulation is applied to the three-dimensional fluid-structure interactions involved in a current reactor safety problem.

56652 (CONF-790802—66) **Quasi-Eulerian formulation for fluid-structure interaction.** Kennedy, J.M.; Belytschko, T.; Schoeberle, D.F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

In this paper, recent developments of a quasi-Eulerian finite element formulation for the treatment of the fluid in fluid-structure interaction problems are described. The present formulation is applicable both to plane two-dimensional and axisymmetric three-dimensional problems. In order to reduce the noise associated with the convection terms, an amplification factor technique is used to implement an up-winding type scheme. The application of the method is illustrated in two problems which are of importance in nuclear reactor safety: (1) a two dimensional model of a cross section of a subassembly configuration, where the quasi-Eulerian formulation is used to model the fluid adjacent to the structures and in the channel between the subassemblies; (2) pressure transients in a straight pipe, where the axisymmetric formulation is used to model the fluid in the pipe. These results are compared to experimental results for these problems and compare quite well.

56653 (CONF-790816—55) **Operational-safety-testing experience at EBR-II.** Sackett, J.I.; Dean, E.M.; Fryer, R.M.; Golden, G.H.; Lambert, J.D.B.; Lehto, W.K.; Singer, R.M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

Operation of EBR-II has required that issues of safety and reliability be continually addressed. This has been necessary not only to support routine operation, but also to support test programs that bear upon safety. Major issues are: (1) operability of fuel elements with breached cladding (local fault prevention); (2) assurance of adequate convective cooling upon loss of pumping power (decay heat removal); and (3) demonstration of benign response of fuel-elements and subassemblies to protected overpower transients (shutdown system margin and reliability. Test programs to address these issues at EBR-II are described. Particular emphasis is given to the potential capability at EBR-II for mild transient testing, consistent with its role in addressing LOA-1 (line of assurance one) safety issues.

56654 (CONF-790935—1) **Behavior of defective LWR-type fuel rods irradiated under postulated accident conditions.** Hobbins, R.R.; Croucher, D.W.; Seiffert, S.L.; Cook, B.A.; Kerwin, D.K.; Mehner, A.S.; Ploger, S.A. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 7p. Dep. NTIS, PC A02/MF A01.

From IAEA specialists meeting on defected zirconium alloy clad ceramic fuel in water cooled reactors; Chalk River, Canada (17 Sep 1979).

The irradiation experiments reported here have been conducted by the Thermal Fuels Behavior Program of EG and G Idaho, Inc., for the United States Nuclear Regulatory Commission in the Power Burst Facility (PBF) at the Idaho National Engineering Laboratory. Five of the rods were irradiated in PCM tests and one in a LOC test. During these tests, the six rods lost cladding integrity prior to or during the transient phase of the test due to either manufacturing defects or intentional rod design and operation. Of the five defective rods tested under PCM conditions, one (Rod IE-008, Test IE-1) had a hydride rupture below the region of the rod, which was in film boiling during the transient; two (Rod A-0021, Test PCM-3 and Rod IE-019, Test IE-5) contained defects (a pin hole and a small axial crack, respectively) within the film boiling zone; and two (Rod 201-1, Test PCM-1 and Rod 205-8, Test PCM-5) failed by cladding embrittlement within the film boiling zone. Rod 312-3 was waterlogged before being subjected to LOC conditions in Test LLR-3.

56655 (CONF-790935—2) **Measurement of fission product release during LWR fuel failure.** Osetek, D.J.; King, J.J. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 7p. Dep. NTIS, PC A02/MF A01.

From IAEA specialists meeting on defected zirconium alloy clad ceramic fuel in water cooled reactors; Chalk River, Canada (17 Sep 1979).

The PBF is a specialized test reactor consisting of an annular core and a central test space 21 cm in diameter and 91 cm high. A test loop circulates coolant through the central experimental section at typical power reactor conditions. Light-water-reactor-type fuel rods are exposed to power bursts simulating reactivity insertion transients, and to power-cooling-mismatch conditions during which the rods are allowed to operate in film boiling. Fission product concentrations in the test loop coolant are continuously monitored during these transients by a Ge(Li) detector based gamma spectrometer. Automatic batch processing of pulse height spectra results in a list of radionuclide concentrations present in the loop coolant as a function of time during the test. Fission product behavior is then correlated to test parameters and posttest examination of the fuel rods. Data are presented from Test PCM-1.

56656 (GRS—4) **Compilation of abnormal events in nuclear power plant, experimental and research reactors for 1966.** Piter, H. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching (Germany, F.R.)). Apr 1978. 112p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

This work is a compilation of abnormal events in reactor facilities for 1966. These abnormal events were collected worldwide and compiled. All these compilations are based on scientific and technical publications, like periodicals, reports and news services. The individual events were classified according to country and, in addition, grouped according to the installation affected, i.e., whether power reactors, experimental reactors, or research reactors. The reporting system, however, was complete only in the United States;

in all other countries, apart from the reporting of serious events, it was more or less left to the discretion of the operating organisation to determine the method and the extent of the reporting of abnormal events. This approach has been changed in the meantime, and this is not only the case in the Federal Republic of Germany, where a systematic compilation and evaluation of abnormal events was introduced in 1975. In the year 1966 no abnormal events had occurred which caused any damage to health or property in the vicinity of reactor facilities. (orig.) 891 HP.

56657 (GRS—12) **Recommendations of the Reactor Safety Commission (RSK) 1975-1977. Vol. 3.** Schneider, M. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching (Germany, F.R.)). Aug 1978. vp. (In German). Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching (Germany, F.R.).

After the recommendations are published in the 'Bundesanzeiger' the Office of the RSK publishes them as a closed report, by order of the Federal Minister of the Interior. The reports are devided in two parts: Part I contains the recommendations which are given by the RSK; part II contains the official notices concerning the RSK. There also is a subject index. Three volumes are published by now: Volume 1: IRS-A-9 (December 1975), Recommendations of the RSK 1971 to 1974 (68th to 96th meeting), pages: I-1 to I-116 and II-1 to II-23 appendix a: RSK-guide lines for PWR, edition 04.74; Volume 2: IRS-A-11 (August 1976), Recommendations of the RSK 1974 to 1975, (97th to 105th meeting), pages: I-117 to I-145; Volume 3: GRS-12 (August 1978), Recommendations of the RSK 1975 to 1977 (106th to 129th meeting), pages: I-146 to I-276 and II-24 to II-25. Volume 3 also contains the recommendation on German Fuel Cycle Center which was given by the Reactor Safety Commision (RSK) in community with the Radiological Protection Commission (SSK), in autumn 1977. (orig./HP) 891 HP.

56658 (HEDL-SA—1713-FP) **Containment air cleaning for LMFBRs.** Hilliard, R.K.; McCormack, J.D.; Postma, A.K.; Owen, R.K. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 11p. (CONF-790816—56). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

A variety of air cleaning concepts was evaluated for potential use in future sodium-cooled breeder reactors. A 3-stage aqueous scrubber system was selected for large-scale demonstration testing under conditions similar to those postulated for containment venting and purging during reactor melt-through accidents. Two tests were performed in the Containment Systems Test Facility using a quench tank, a jet venturi scrubber and a high efficiency fibrous scrubber in series. The results of two tests with Na_2O_2 and NaOH aerosol and NaI vapor are presented showing >99.9% removal of Na_2O_2 and NaOH and >99.7% for NaI.

56659 **Structural failure of thick-walled concrete elements.** Ottosen, N.S.; Andersen, S.I. (Research Establishment Risoe, Roskilde (Denmark)). pp H4/3 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

One part of this paper deals with the final structural experiences obtained from experimental tests performed at Risoe of the overload behaviour of elements of the Scandinavian PCRV-concept for BWR's, the other part deals with corresponding, non-linear, finite-element modelling and constitutive equations for concrete.

56660 (IDO—1570-T19) **Power Burst Facility fission product detection system.** Osetek, D.J.; Coates, R.A.; Johnson, L.O.; Killian, E.W.; King, J.J. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 32p. Dep. NTIS, PC A03/MF A01.

Fuel performance tests at the Idaho National Engineering Laboratory (INEL) offer a unique opportunity for detailed studies of fission product behavior during light water reactor (LWR)-type fuel failure. A fission product detection system (FPDS), which includes an advanced gamma spectrometer, was installed on the test loop of the Power Burst Facility (PBF) to provide continuous measurement of the fission product concentrations in the coolant. The detection system instrumentation is discussed in detail with emphasis placed on the advanced features. Examples are shown of gross detector response and reduced spectrometer data which indicate test fuel condition and fission product behavior. Performance of the system during initial tests has exceeded expectations, and the project is now contributing significantly to fission product behavior research.

56661 (INIS-mf—4280, pp 156-162) **Hydrodynamics of emergency cooling of a sodium-cooled fast reactor.** Macek, J.; Pfann, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

A mathematical model is described permitting the quantitative study of transients in the primary coolant circuit and in the core of a sodium-cooled fast reactor in a loop configuration. The possibility of sodium boiling is not considered. The circuit is described using a system of nonlinear differential equations, the initial conditions for the solution of the system are based on the steady nominal state. The analytical solution is described of the outage of all pumps and simplifications facilitating the solution are given. A modified Runge-Kutta method permitting the automatic adjustment of the integration step length thus considerably accelerating the whole calculation, proved suitable for the integration of the nonlinear system of differential equations. The model is applicable not only for emergency after-cooling but also for other transients provided the steam phase is not formed in the coolant. The derived analytical relations facilitate good orientation in the changes in the flow rate and the pump run-out.

56662 (INIS-mf—4280, pp 19O-196) **Hydrodynamical experiments on an enlarged model of a fast reactor fuel assembly.** Mantlik, F.; Hejna, J.; Cervenka, J. 1976. (In Czech).

From Scientific and technical conference commemorating the 20. anniversary of the Nuclear Research Institute's foundation; Rez, Czechoslovakia (10 Jun 1975).

The HEM-1 equipment in the Nuclear Research Institute is designed for the hydrodynamic research of fuel assemblies of fast power reactors of the BN-6O0 type, intended for obtaining information on hydrodynamic conditions in an infinite rod bundle with a local geometrical failure. The model consists of 19 aluminium tubes with a relative spacing of 1.17 enclosed in a hexagonal containment whose walls are in contact with the side tubes. The outer tube diameter is 120 mm, the total model length is 6 m. The central tube may be deflected towards one or two neighbouring tubes to contact. Static pressure is measured by two probes on each of four measuring rods and by 27 probes spaced evenly along the channel length by 250 mm. Static pressure measurement shows that the pressure gradient may be considered to be constant starting at a distance of 2000 mm from the inlet, i.e., about 40 hydraulic channel diameters.

56663 (INIS-mf—4470, pp vp) **Analytical studies of a finite six-channel blockage in a LMFBR subassembly.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56664 (INKA-Conf—78-078-001) **Advances in reactor safety research and its role in safety assessment.** Fischer, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). 1978. 35p. (In German). (CONF-781147—2). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 6. meeting of the projekt nukleare sicherheit; Karlsruhe, F.R. Germany (28 Nov 1978).

On the basis of his own studies, the author discusses the main advances in reactor safety research and its role in safety assessment.

56665 (JAERI-M—7505) **ROSA-II test data report, 11. Effects of break area distribution and circulation pump on core flow (runs 327, 328, 329, 330).** (Japan Atomic Energy Research Inst., Tokyo). Feb 1978. 162p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

Results of the ROSA-II tests simulating a loss-of-coolant accident (LOCA) and effects of an emergency core cooling system (ECCS) in a pressurized water reactor (PWR) are presented including the test conditions and interpretations of the data in test runs 327,328,329 and 330. Each test was performed with large double-ended hot leg break and effect of the break area distribution (break diameter are 25.0 mm at one end and 37.5 mm at the other end of break) and of pump circulation upon coolant flow in the core were studied. The following are the results: In the case of a smaller break on the steam generator side, core cooling was achieved due to upward coolant flow in the core and early reflooding by ACC water injected into the cold leg. In the case of a smaller break area on the vessel side, on the other hand, coolant flow in the core was stagnant and the heater rods were mostly exposed to steam, so that core cooling was not as good. Effect of the coolant circulation by acting pump on the core cooling during a blowdown was not significant except that in a steam generator side small break the core cooling was improved.

56666 (JAERI-M—7569) **Data processing in reflood experiments.** Sugimoto, J.; Sudoh, T.; Sudo, Y.; Iguchi, T.; Murao, Y. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 60p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Data Processing in reflood experiments consists of experimental data conversion and heat transfer coefficient calculation. Described are method of data processing, principle of codes, programs, examples in each process, and also problems for the future. Improvement in data processing is proceeding along with reflood experiment.

56667 (JAERI-M—7579) **Measurement of FP plate-out using a portable Ge(Li) detector. Preliminary measurement of FP plate-out with OGL-1.** Katagiri, M.; Terada, H.; Takahashi, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 63p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

In safety analysis of a multi-purpose high-temperature gas cooled reactor, it is important to evaluate the amount of fission product (FP) plate-out in piping and machinery of the primary circuit. Germanium spectroscopy of gamma-rays due to the plate-out appears to be useful. Preliminary measurement of FP plate-out was made preceding the FP plate-out measurement project with high-temperature gas loop OGL-1. The purpose was to confirm effectiveness of the method and reveal technical problems. Upon termination of 39th cycle and 40th cycle of JMTR operation, using a portable Ge(Li) detector and lead collimator, an in-pile tube, three high-temperature pipes, a regenerative heat exchanger and a filter in the OGL-1 were measured. Plate-out nuclide ^{131}I, ^{133}I, ^{95}Zr, ^{95}Nb, ^{99}Mo, ^{60}Co, ^{58}Co, ^{51}Cr, ^{54}Mn, ^{65}Zn, ^{59}Fe, sup(110m)Ag, ^{122}Sb, ^{124}Sb, ^{182}Ta, ^{140}La, ^{46}Sc, ^{181}Hf, ^{24}Na and ^{137}Cs could be identified, with concentrations of $10^{-5}\mu Ci/cm^2$ -- $10^{-2}\mu Ci/cm^2$. The method was found to be effective, and useful results could be obtained for the FP plate-out measurement project.

56668 (JAERI-M—7583) **Computer code for the analysis of destructive pressure generation process during a fuel failure accident, PULSE-2.** Fujishiro, T. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 39p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The computer code PULSE-2 has been developed for the analysis of pressure pulse generation process when hot fuel particles come into contact with the coolant in a fuel rod failure accident. In the program, it is assumed that hot fuel fragments mix with the coolant instantly and homogeneously in the failure region. Then, the rapid vaporization of the coolant and transient pressure rise in failure region, and the movement of ejected coolant slugs are calculated. The effect of a fuel-particle size distribution is taken into consideration. Heat conduction in the fuel particles and heat transfer at fuel-coolant interface are calculated. Temperature, pressure and void fraction in the mixed region are calculated from the average enthalpy. With physical property subroutines for liquid sodium and water, the model is usable for both LMFBR and LWR conditions.

56669 (JAERI-M—7609) **Analysis of steam entry reactivity worth experiments in the gas-cooled fast reactor.** Iijima, S.; Yoshida, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 28p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The steam entry reactivity effect on gas-cooled fast reactor is one of the most important safety-related physic parameters as is the sodium void reactivity effect in LMFBR. Steam entry reactivity worth experiments in a prototype GCFR were analysed to examine reliability of the fast reactor group constant set and computation codes used in design studies of LMFBR and GCFR. The experiments were made in the ZPR-9, Phase-I and Phase-II assemblies at ANL as one of the benchmark reactor physics experiments for the 300 MWe GCFR demonstration plant in the U.S. Analysis of the experiments is based on two-dimensional R-Z diffusion approximation with unisotropic diffusion coefficients and JAERI-FAST 25-group cross section set. Calculated results underestimate the relatively large positive values of measured steam entry reactivity worth. This is because the calculation is not able to consider the neutron spectrum softening due to ingression of steam into the core. In order to solve the large difference between experiment and calculation, therefore detail studies are necessary on cross section of nuclides and the calculation methods including transport theory.

56670 (JAERI-M—7627) **Systems analysis by fault tree method. II. System reliability analysis code FALCOM.** Suzuki, K.; Ogura, K. (Japan Atomic Energy Research Inst., Tokyo). May 1978. 52p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

It is important to introduce reliability engineering to the design of a nuclear power plant in order to improve its availability. The computer code FALCOM developed is described which is for analysing effects of preventive and corrective maintenances by FAULT TREE METHOD. Calculated with the code are the following: (1) unavailability of a system with parts maintained correctively or preventively, and (2) classification of minimal-cut-sets and analysis of system reliability. Results of two example calculations are also given.

56671 (JAERI-M—7656) **Experiment on performance of upper head injection system with ROSA-II. Second volume.** (Japan Atomic Energy Research Inst., Tokyo). May 1978. 150p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

Of the total 10 ROSA-II/UHI performance tests, 6 were reported previously. The rest are presented and discussion is made on the effects of heat generation in the core and UHI injection and repeatability of experiments. In addition, the following are described: (1) Pressure spikes observed in the upper head after sudden stoppage of UHI injection, and (2) discharge flow oscillation possibly due to UHI water injection into the upper plenum.

56672 (Juel—1517) **Consequence analyses of hypothetical accidents of high temperature gas-cooled reactors. Pt. 2/3. Fission product release from a high temperature reactor core during unlimited core heat-up for the HTR-1160 as an example.** Mueller, A.; Badur, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung). Jun 1978. 41p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

With regard to a hypothetical accident which is characterized by the rupture of the primary circuit and by the additional failure of active engineered safeguards, the fission product release resulting from the unlimited core heat-up is analyzed. The applied models are explained and the data base being used is documented. The generally conservative treatment yields pessimistic activity release rates into the containment. The results show in particular that spontaneous massive fission product release does not occur. The time-dependency of the activity release from the fuel elements, the primary circuit and at last from the containment leads to a time delay in the range of at least several hours, before the environmental radiation load is raised. Ultimately the maximum radiation load itself proves relatively favourable. (orig.) 891 HP.

56673 (Juel—1522) **Development of a core material safety system for the THTR 300 pebble bed reactor.** Engelhardt, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.); Hochtemperatur-Reaktorbau G.m.b.H., Juelich (Germany, F.R.); Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG), Uentrop (Germany, F.R.)). May 1978. 83p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Summarising the safety concept for the THTR 300 envisages nine 'strategic points', of which three are 'key measurement points', corresponding to the spatial arrangement of the core materials. Corresponding to the definition of the term 'strategic point' according to the verification agreement, in testing plant parameters one obtains the necessary and sufficient information for carrying out safety measures together with information from all the strategic points. This information can easily be checked at the above mentioned points. First estimates of the extent of inspection for this plant according to the international safeguard guidelines give a considerably lower value than for the verification agreement (VA) for this type of plant (article 80 of the VA: 50 inspector mandays). The safety concept for the THTR 300 described here therefore fulfils the requirements made of a safeguard system: It effectively supplies the proof of non-abstraction of core material (article 28, VA) with an economic use of the available means of inspection (article 78, VA) and a reasonable effect on operation (article 5a, 5b VA). (orig./HP) 891 HP.

56674 (KFK—2662) **Theoretical investigations of the meltoff and resolidification process of fuel claddings during accidents in liquid metal cooled fast breeder reactors.** Angerer, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter; Karlsruhe Univ. (TH) (Germany, F.R.). Fakultaet fuer Maschinenbau). Aug 1978. 182p. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

Thesis.

During loss-of-coolant-flow accidents in liquid metal cooled fast breeder reactors with failure to scram the fuel claddings will melt after boiling and evaporation of the coolant. The CMOT model presented here describes the subsequent process of relocation and resolidification of the molten claddings. The basic thermohydrodynamics equations of the two-phase flow of cladding material and sodium vapor are solved numerically by differential approximations in a Eulerian reference net. The results calculated by the model improved the insight into the dynamics of the cladding relocation process. Here are the main results: - Shortly after the onset of cladding relocation large waves of molten cladding material are generated. The motion of these waves contributes considerably to the material transport. - The dynamics of cladding relocation exhibits strong local incoherences. - The formation of cladding blockages observed at the ends of the fuel region is confirmed by the calculations. - In case of incoherent cladding meltoff less cladding material is transported upwards. - Cladding relocation strongly depends on the axial pressure drop and the underlying friction factor correlations. Recalculation of the R5 loss-of-coolant-flow experiment performed in the U.S. TREAT test reactor is in good agreement with the experimental data. (orig./HP) 891 HP.

56675 (KFK—2664) **Experimental investigation of the activation of primary cycle in pressurized water reactors.** Michael, I. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Sep 1978. 59p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The report describes work carried out within the framework of the reactor safety research program and concerned with the analysis of radiation exposures caused by the operation of nuclear power plants equipped with PWR, and with problems of the release and transport of radioactive substances in primary circuits. The efforts are concentrated mainly on the respective reduction measures. The metal release and the corrosion of steam generator tube materials in pressurized water (340°C, 150 bar) were studied in two autoclaves as a function of water chemical measures taken to reduce the oxygen content and for additional alcalinization of the feed water. In these studies the different mechanical and thermal previous treatments of tube materials of similar compositions played an important role. Flameless atomic absorption analysis was used for water chemical analysis. The thin film analysis of the corrosion layers was done by secondary ion mass, Augerelectron spectroscopy and by interference microscopy. (orig.) 891 HP 892 AP.

56676 (KFK—2712) **Heat transfer measurements of internally heated liquids in cylindrical convection cells.** Fieg, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Oct 1978. 28p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In hypothetical reactor accidents, the thermohydraulic behaviour of core melts heated by the after-heat must be analyzed. For this purpose model experiments have been performed to study the stationary, natural convective heat transfer of internally heated fluids in cylindrical convertion cells investigating also the influence of geometry (aspect ratio) as well as of difference thermal wall conditions on to the heat transport characteristics. Axial temperature profiles, local heat flux densities at the vertical walls and their dependence, on the external Rayleigh number ar in detail reported, besides the Nusselt vs Rayleigh correlations for the aspect ratios HID=1 and 0,25. The results of these experiments are compared, as for ar possible, with existing thermohydraulic codes and simpler model asoumptions like the zone-model of Baker et. al. and after experimental verification, be used to study realistic PAHR situations. Velocity measurements by means of Laser-Doppler-Method yield information about the flow characteristics near the vertical walls and within the central part of the convecting fluid.

56677 (KFK-EXT—8/78-2) **SSYST-1 input description for the modules of the program system.** Gulden, W.; Meyder, R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Jun 1978. 173p. (In German). (IKE—4-42). Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung.

The modules of the SSYST program system allow the detailed analysis of an LWR fuel rod in the course of a postulated loss-of-coolant accident. They provide a tool for considering the interaction between the heat conduction in the fuel rod, heat transfer in the gap, fuel and cladding tube deformation, pressure in the coolant, as well as thermal and fluid dynamics in the cooling channel and for calculating the time and location of ballooning and rod failure, respectively. They can be used both to precalculate the behavior of fuel rods during LWR accidents and in support of the design of experiments. Depending on the problem to be solved, the individual modules can be easily combined.

56678 (KFK-EXT—28/78-1) **Status and results of the theoretical and experimental investigations on the LWR fuel rod behavior under accident conditions. An interim report, December 1977.** Bocek, M.; Hofmann, P.; Leistikow, S.; Class, G.; Meyder, R.; Raff, S.; Erbacher, F.; Hofmann, G.; Ihle, P.; Karb, E. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Sep 1978. 143p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01.

In this report the status of knowledge is described which has been gathered up to the end of 1977 on the LWR fuel rod behavior in loss-of-coolant accidents. The majority of results indicated have been derived from studies on the fuel rod behavior performed within the framework of the Nuclear Safety Project (PNS); partly, also the results of cooperating research establishments and fm international exchange of experience are referred to. The report has been subdivided into two complete parts: Part I provides a survey of the most significant results of the theoretical and experimental research projects on fuel rod behavior. Part II describes by detailed individual presentations the status as well as the results with respect to the major central subjects. (orig.) 891 RW 892 AP.

56679 (LA—7938-C) **Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.** Stevenson, M.G. (comp.). (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 343p. Dep. NTIS, PC A15/MF A01.

Separate abstracts are included for each of the papers presented concerning the performance of reactor components and materials under accident conditions.

56680 (LA—7938-C, pp 9-20) **Fuel crack volume predictions and measurements.** Fox, G.L.; Randklev, E.H. (Hanford Engineering Development Lab., Richland, WA). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Void volume within an FBR fuel pin has a substantial effect on calculations of cladding strain and lifetime for transient overpower accident analyses. A substantial fraction of this void volume is contained within startup cracks that are still present during fuel irradiation. This paper discusses a crack prediction method, crack measurement techniques, compares predictions with measurements, and includes a sufficient crack fraction data base to be of use to other fuel pin behavior analysts.

56681 (LA—7938-C, pp 21-38) **Influence of thermal cracking on transient pre-failure molten fuel motion.** Kuczera, B.; Billaux, M. (Kernforschungszentrum, Karlsruhe, Germany). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Under hypothetical transient conditions analyzed in the frame of safety investigations of LMFBRs, the fuel pin will undergo various modifications which influence remarkably the instant and the location of the clad failure. The essential part of the present contribution concerns cracked fuel behaviour and transient pre-failure fuel relocation. Enhanced by experimental evidences a new transient model, called BREDA-III A, was developed which allows a more detailed simulation of the fuel pin behaviour under accident conditions until pin failure. The application of the model has led to a better understanding of the sequence of physical events observed during moderate transient overpower (TOP) experiments.

56682 (LA—7938-C, pp 39-51) **Analysis of internal fuel motion during PINEX-2 experiment.** Padilla, A. Jr.; Baars, R.E.; Porten, D.R.; Randklev, E.H. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

This paper describes the analyses performed for the PINEX-2 experiment to calculate the ejection of molten fuel into the reflector and fission gas plenum for an internally-vented fuel pin during a simulated 5$/s transient overpower excursion. The LAFM code was used to predict the transient fuel melting and fission gas release, and the HOTPIM and FUMO-T codes were used to predict the fuel ejection. The analytical results were compared with initial data from both the Pinhole-TV Imaging System and the fast-neutron hodoscope, as well as post-transient examinations of the fuel pin.

56683 (LA—7938-C, pp 52-66) **PINEX II: French contribution to an international benchmark experiment.** Melis, J.C.; Meyer-Heine, A. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

This note presents briefly the code PHYSURA used to interpret safety experiments. As an application, the French contribution to an international benchmark test, PINEX 2, is described. The results show that a simple code like PHYSURA gives good results even for such a complex experiment.

56684 (LA—7938-C, pp 67-84) **PINEX-AR, a fuel dynamics code applied to PINEX-2 prediction and reactor analysis.** Coddington, P. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The PINEX-AR code is a fuel dynamics code that incorporates a heat transfer calculation to provide fuel and clad temperatures, a fission gas release routine, a method for determining the gas pressure within the molten fuel, the evaluation of the movement of molten fuel along the fuel pin and breeder central hole, and a determination of clad failure by reference to clad strain and molten fuel melt through. The code has been successfully applied to the PINEX-2 transient and demonstrates that molten fuel will be pushed into the gas plenum region and that the fuel pin clad is not expected to fail. The code has also been applied to fast reactor overpower transients and shows that molten fuel behavior similar to PINEX-2 can be expected for fast transients, whereas for slow transients the central hole is predicted to plug due to frozen fuel.

56685 (LA—7938-C, pp 85-98) **Clad strain and melt-through failure mode analysis for fast-running application.** Moorhead, T.P. (Atomic Energy Establishment, Winfrith, England). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

A system of calculations representing various phenomena affecting fuel pin failure in accident transients is described, which is simple and fast enough for repetitive calls and yet retains a sound

physical basis with experimental background. Its current implementation in the whole-core accident code FRAX-2 is illustrated.

56686 (LA—7938-C, pp 99-115) **FRESS pin failure model and its application to E-8 TREAT test.** Kalimullah. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

FRESS is a cladding rupture prediction model for an irradiated mixed-oxide LMFBR fuel pin during transient heating based only on the internal pressurization of the cladding by the fission gas released from fuel grains during the transient. The model is applied to the analysis of the hottest PNL-10-53 pin in the 7-pin E-8 TREAT test which simulates a $3/sec transient overpower. Although the uncertainties of the inputs to the temperature calculation done with the COBRA code have not been included, the uncertain input parameters to FRESS have been varied over their estimated uncertainties. The cladding rupture predictions are a few tens of milliseconds late compared to the most probable failure time detected in the test. However, these calculations seem to indicate that fission gas pressure is a significant mechanism for causing clad rupture in this test.

56687 (LA—7938-C, pp 116-121) **Fuel pin modeling of the fresh oxide/sodium prompt burst energetics experiments.** Young, M.F. (Sandia Labs., Albuquerque, NM). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

A series of twelve Prompt Burst Energetics (PBE) experiments utilizing fresh uranium dioxide fuel in stagnant sodium coolant have been performed in Sandia Laboratories' Annular Core Pulse Reactor (ACPR). PBE experiments are designed to study the energetic response of important reactor fuel-clad-coolant systems under superprompt critical conditions. The direct aim is to identify and characterize the phenomena resulting in pressure generation and the conversion of thermal energy to work. Other PBE experiments have involved fresh UO_2 fuel in a helium filled capsule and fresh UC fuel in stagnant sodium. This paper presents results of this series of experiments and related analysis done with a pin model, EXPAND, developed to predict pin failure time and location for fresh fuel pins. The model also gives temperatures and pressures at failure for the fuel-clad-coolant system, which are used as initial conditions for analysis of the post-failure behavior of the ruptured fuel pin.

56688 (LA—7938-C, pp 122-124) **Sodium boiling with stainless steel clad melting and relocation out-of-pile experimental results and interpretation.** Seiler, J.M. (Commissariat a l'Energie Atomique, Grenoble, France). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

A feasibility test of out-of-pile sodium boiling experiments with stainless steel clad melting has been successfully achieved at the Nuclear Research Center of Grenoble in December 1978 on the CESAR loop. Transient sodium boiling development, dry-out apparition, clad melting, and relocation could be followed.

56689 (LA—7938-C, pp 125-140) **Hydrodynamic fragmentation of drops.** Patel, P.D.; Theofanous, T.G. (Purdue Univ., West Lafayette, IN). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Studies of the morphology of fragmentation of liquid drops in a liquid medium due to shock-induced flows are reported. For high density ratio and high interfacial tension systems, the fragmentation is found to be probably due to the penetration of the drop by unstable waves. An envelope of conditions which characterize drop breakup in these systems has been deduced. Analytical models, which involve the time constants of both the drop-piercing Taylor instability and the wake-forming shear effects, reflect our experimental results well. In addition, it is found that the mercury-water system studied here should simulate the uranium dioxide/sodium pair, which is of interest in safety studies of fast reactors.

56690 (LA—7938-C, pp 141-152) **Fuel and coolant motions following pin failure: EPIC models and the PBE-5S experiment.** Garner, P.L.; Abramson, P.B. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The EPIC computer code has been used to analyze the post-fuel-pin-failure behavior in the PBE-5S experiment performed at Sandia Laboratories. The effects of modeling uncertainties on the calculation are examined. The calculations indicate that the majority of the piston motion observed in the test is due to the initial pressurization of the coolant channel by fuel vapor at cladding failure. A more definitive analysis requires improvements in calculational capabilities and experiment diagnostics.

56691 (LA—7938-C, pp 153-162) **Analysis of TREAT transient overpower experiments using the PLUTO codes.** Wider, H.U.; Semenza, L.A. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Pre- and post-test computer analyses of TREAT transient overpower test H6 are presented and compared with an earlier analysis of E8. The computer models used were the PLUTO code and its successor, the PLUTO2 code. A good agreement with several events could be achieved in the post test simulations, which supports the basic modeling in the codes used. The pre-test analyses suffered from the uncertainty in the pin failure sequence. Fission-gas pressures in the pins at failure time were on the order of 15 to 30 MPa in both tests. Plenum fission-gas release may have played an important role in both tests. Although a stronger FCI tended to be promoted by the larger hydraulic forces in the H6 test with its higher pump pressure and flow velocity, the voiding was less pronounced for the same reasons. Fuel sweepout from short EBR-II irradiated pins failing into non-voided channels tended to be on the order of 5 to 20 g of fuel per pin.

56692 (LA—7938-C, pp 163-177) **Fundamental aspects of molten clad relocation.** Marrotte, G.N. (General Electric Corp., San Jose, CA); Theofanous, T.G. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Experimental data on the transient motion of a suddenly sheared vertical liquid-metal film and its mechanical interaction with the driving gas flow are presented. New correlations describing these phenomena, and application to high interfacial tension systems are derived from these data and applied to the prediction of clad relocation dynamics in LMFBR core melt accidents.

56693 (LA—7938-C, pp 178-184) **Comparison of the predictions from the multichannel clad relocation model to available in-pile experimental data.** Ishii, M.; Chen, W.L.; Kuzay, T.M. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

In a hypothetical unprotected undercooling accident in liquid-metal fast breeder reactors, coolant sodium is rapidly heated to boiling. The sodium boiling leads to the dryout and eventual melting of the cladding. The cladding motion upon melting is considered to be important in determining the reactivity effect, blockage formation, and its effect on subsequent fuel motion. A computer code MULCLAD which is based on multi-channel cladding motion model is used for the comparative studies with available experimental data. R4 and R5 TREAT in-pile test and 37 pin P3A test by SLSF Project in the Engineering Test Reactor have been analyzed in detail.

56694 (LA—7938-C, pp 185-196) **Simulation of cladding relocation in the TREAT-experiment R5 with the CMOT code.** Angerer, G.; Woll, D. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The CMOT code is an analytical tool to simulate cladding motion after melting and its resolidification and blockage formation in voided coolant channels during hypothetical core disruptive accidents in LMFBR's. It was applied to the TREAT experiment R5 to check whether the code is able to correctly reproduce the cladding relocation process. The agreement achieved between experimental and analytical data is encouraging. The results show that cladding relocation may be simulated by the assumption of motion of the molten cladding as a film along the fuel pin surface. The results also show that wave formation and wave motion are important cladding transport mechanisms.

56695 (LA—7938-C, pp 197-217) **Analysis of fuel behaviour in SCARABEE 1st phase experiments.** Schmitz, F.; Matthews, J.R. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

After a short description of the SCARABEE first phase program and of the approach adopted in the interpretation, the main experimental results used for the fuel behaviour analysis are given. Calculation results from the different computer codes are then compared to the experimental results.

56696 (LA—7938-C, pp 218-241) **SIMMER-II analysis of the R-7 TREAT test.** Bohl, W.R. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The SIMMER-II code was used in a simulation of the R-7 loss-of-flow TREAT test. Comparison with the test scenario encompassed thermocouple data, flowmeter traces, hodoscope data, and the posttest configuration. Reasonably successful results were obtained on the overall heat balance. The calculated boiling time was within 0.2 s of the experimental result, and respectable agreement

with the integrated lower flowmeter trace was achieved over the first 2 s of boiling. Although the details of cladding relocation and blockage formation could not be well simulated, the calculated fuel motion appears to be plausible given the available experimental information. It was further concluded that this type of study is quite useful for revealing areas for model improvement.

56697 (LA—7938-C, pp 242-256) **Analysis of TREAT tests L7 and L8 with SAS3D, LEVITATE and PLUTO2.** Bowers, C.H.; Tentner, A.M.; Wider, H.U. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

Fuel motion in TREAT Tests L7 and L8 is analyzed with the SAS3D, LEVITATE, and PLUTO2 computer codes. These results are compared with fuel motion data obtained from the fuel neutron hodoscope. It is concluded that fission gas acts to disperse fuel during the early stages of fuel motion.

56698 (LA—7938-C, pp 257-268) **Comparison of FISGAS swelling and gas release predictions with experiment.** Ostensen, R.W. (Sandia Labs., Albuquerque, NM). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

FISGAS calculations were compared to fuel swelling data from the FDI tests and to gas release data from the FGR39 test. Late swelling and gas release predictions are satisfactory if vacancy depletion effects are added to the code. However, early swelling predictions are not satisfactory, and early gas release predictions are very poor. Explanation of these discrepancies is speculative.

56699 (LA—7938-C, pp 269-279) **Analysis of fuel dispersal in direct electrical heating experiments.** Gruber, E.E.; DiMelfi, R.J.; Bandyopadhyay, G. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The effects of transient history on fuel motion driven by fission gas have been investigated in a series of direct-electrical-heating tests on quartz-clad irradiated fuel. Variations in the slow, Stage-I portion of the transient thermal history resulted in pronounced differences in fuel behavior during the subsequent, more rapid, Stage-II portion. Analysis of transient fission-gas behavior, considering both the timing of gas release to grain boundaries and the non-equilibrium character of grain-boundary gas bubbles, provides a coherent picture of the role of fission gas in the observed fuel failure. The results indicate the conditions under which fission gas may efficiently drive expulsion of molten fuel through cracks, as well as conditions under which gross radial swelling of the fuel may be expected. These predictions are compatible with the observed nature of fuel failure.

56700 (LA—7938-C, pp 280-300) **Analysis of a prototypic and a simulant experiment related to freezing in flow channels.** Hakim, S.J. (Argonne National Lab., IL). Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

An analysis is presented of two experiments, one involving simulant materials, and a second more prototypic experiment, related to freezing of molten LMFBR core material in flow channels. Good agreement is obtained between predictions and experimental results for both experiments. It is argued that simulant experiments could provide a reasonable vehicle for validation of isolated phenomena related to the freezing process while prototypic experiments provide a more realistic view of the integrated behavior of molten core material during the accident.

56701 (LA—7938-C, pp 301-307) **Molten fuel relocation and connected problems: the GELCO code, comparison with experimental results, application to reactor.** de Lapparent, D. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The problem of fuel freezing is illustrated in the case of a Hypothetical Core Disputive Accident. The GELCO Code and an experiment using molten UO_2 are presented. A tentative application is made to Reactor conditions.

56702 (LA—7938-C, pp 308-319) **SIMMER analysis of SRI high pressure bubble expansion experiments.** Rexroth, P.E.; Suo-Anttila, A.J. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

SIMMER-II was used to analyze the results of the SRI nitrogen bubble expansion experiments. Good agreement was found for all of the experiments analyzed as well as the theoretical isentropic limiting case. Scaling to a full size CRBR reactor reveals no significant scaling effects for the structureless core.

56703 (LA—7938-C, pp 320-334) **Termination phase of core disruptive accidents in LMFBRs.** Saito, M.; Theofanous, T.G. Jul 1979.

In Specialists' workshop on predictive analysis of material dynamics in LMFBR safety experiments, March 13-15, 1979.

The most significant finding of this work is that the presence of entrainment during bubble growth was found significantly less than expected on the basis of the current literature. A small amount of entrainment is seen as the impact is approached and a new entrainment mechanism is suggested. Additional study of this region will be required to predict the extent of entrainment and quantify its impact on energy release.

56704 (STUDSVIK-BL—78-26) **Fission product migration in intact fuel rods. S178 experiments 4-6: fission product volatility at 1200 deg C.** Blackadder, W.; Forsyth, R.; Malen, K.; Nilsson, B.Aa.; Wikstroem, C. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug 1978. 53p. Dep. NTIS (US Sales Only), PC A04/MF A01.

In order to investigate the possible volatilization of fission products such as caesium, iodine and tellurium during an hypothetical LOCA intact irradiated fuel rods have been heated up to 1200 deg C. The volatility of caesium and iodine was lower than expected. Only at temperatures of 1100-1200 deg C could we detect axial migration of caesium. No iodine reached the plenum even when most of the rod was at 1200 deg C.

56705 (TFBP-TR—332) **PBF-LOCA Test Series: Test LOC-5 experiment predictions.** Waterman, M.E.; Yackle, T.R. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1979. Contract EY-76-C-07-1570. 58p. Dep. NTIS, PC A04/MF A01.

The Loss of Coolant Accident (LOCA) Test Series being conducted in the Power Burst Facility (PBF) at the Idaho National Engineering Laboratory has been designed to provide data for the development and the assessment of fuel behavior computer codes used to predict the response of a pressurized light water reactor (PWR) during a hypothetical break in the cold-leg inlet or hot-leg outlet. This report presents the experiment predictions for the four-rod LOCA test, LOC-5. An analysis was performed to predict the test fuel rod and system behavior during a typical LOC test. Reactor physics calculations were performed with the RAFFLE code to determine the relationship between test fuel rod powers and the PBF reactor power during both the steady state operation and during the blowdown. Calculation of the system thermal-hydraulic response during blowdown, made with the RELAP4 computer code, provided the coolant and heat transfer boundary conditions for the fuel behavior calculations. Cladding and fuel rod dimensions for the rods previously irradiated in the Saxton reactor were determined with the FRAP-S code. Finally, the rod thermal and mechanical behavior during the blowdown transient were determined with the FRAP-T5 code.

56706 (UCID—18270) **Identification, detection, and validation of vibrating structures: a signal processing approach.** Candy, J.V.; Lager, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1979. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

This report discusses the application of modern signal processing techniques to characterize parameters governing the vibrational response of a structure. Simulated response data is used to explore the feasibility of applying these techniques to various structural problems. On-line estimator/indentifiers are used to estimate structural parameters, validate designed structures, and detect structural failure when used with a detector.

56707 (ANL-Trans—1177) **Report of study on safety with respect to sodium water reaction. Section 4. Water leak rate evaluation in the large scale sodium water reaction. Section 5. Concluding remarks. Appendix. Analysis code: summary.** (Japan Society of Mechanical Engineers, Tokyo). Jul 1979. Translation of Japanese report, March 1978, pp 143-261. 175p. Dep. NTIS, PC A08/MF A01.

Methods for the estimation of water leak rate in an experiment on large-scale sodium water reactions are evaluated.

56708 **Electrical aspects of safety related equipment in nuclear power plants.** Rubenstein, L. (Stone & Webster Engineering Crop., New York, NY). pp 7p, Paper A 78 046-5 of IEEE Power Engineering Society text of "A" papers from the winter meeting. New York, NY; Institute of Electrical and Electronics Engineers, Inc. (1978).

From Power Engineering Society winter meeting; New York, NY, USA (29 Jan 1978).

This paper suggests a general method of approach to aid in compliance with various Nuclear Regulatory Commission (NRC) guides and design criteria by maximizing the use of separation of circuits and minimizing the number of associated circuits. Safety aspects of electrical design of a typical power plant are discussed with attention paid to differences between NRC and IEEE criteria. Some common problems not specifically referred to in NRC Regulating Guides or IEEE standards are discussed.

56709 **Explosive rupture of a power channel pressure tube in a D_2O moderated reactor.** Dallavalle, F.; Hotz, W.; Possa, G. (Centro

Informazioni Studi Esperienze, Milan (Italy)). pp F8/2 1-16 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

For the D_2O moderated reactors, the explosive rupture of a power channel pressure tube is one of the hypothetical accidents which are to be considered for the full assessment of the system safety. The purpose of this paper is to give a coherent presentation of the main aspects and problems encountered in the evaluation of the consequences of this hypothetical accident. The explosive rupture of the pressure tube is assumed to be due to the fast propagation of a longitudinal crack of critical length. This very unlikely rupture mechanism is by far the most dangerous conceivable. For the case of the CIRENE reactor, on the basis of a wide set of burst tests, it can be concluded that even in the most severe accident conceivable, pressure tube rupture propagation from one power channel to the adjacent one is very unlikely, the peak transverse force due to explosion being limited to approximately 100 N/mm channel height at most, and lasting only a few ms. In addition, the dynamic loads in core structures caused by the pressure peaks in the D_2O tank, do not produce any relevant damage to the main structural functions.

56710 Response of simple, scale model reactor vessels to a simulated HCDA loading. Cagliostro, D.J.; Romander, C.M.; Florence, A.L. (Stanford Research Inst., Menlo Park, CA (USA). Poulter Labs.). pp E2/4 1-12 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

To help evaluate the safety of LMFBRs, computer codes have been developed for predicting the structural response of LMFBRs to HCDAs. Validation of these codes is best done by performing experiments with simple scale models of a reactor. The work described here was performed to verify modeling techniques used in two-dimensional axisymmetric fluid-structure-interaction codes. A well-defined energy source with precision tolerances, and simple boundary conditions and the loading, strain, and deformations were measured. The experiments were performed in thick-walled and thin-walled vessels that are approximately 1/30-scale of the Clinch River Breeder Reactor (CRBR). The results of these experiments are presented in a form suitable for verifying two-dimensional fluid-structure codes designed to predict the response of reactor vessels to HCDA loads.

56711 Effects of spacers on blockage of coolant channels in clad melting accidents. Eggen, D.T.; Scale, T.; Hsieh, S. (Northwestern Univ., Evanston, IL (USA). Technological Inst.). pp E3/11 1-9 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Following a loss of flow condition in a GCFR fuel assembly, the cladding will melt and flow out of the core. Grid-type spacers are located in the channels and impede and change the flow patterns of the melted cladding. If the cladding reaches the cooler blanket region there is the potential to refreeze and block the channels resulting in reactivity increases and further loss of flow. Experimental studies of simulated fuel elements and bundles have been conducted and models have been developed to correlate the observations. The elements and configuration of these assemblies are representative of the current design for a GCFR. Three series of experiments have been conducted to study the flow and disposition of molten cladding metal into a lower powered blanket region of the reactor following a loss of flow situation. The first two series used a simulant fuel-element bundle to simplify the experimental procedure and make visual observation possible. The third set of experiments was done with a stainless steel bundle of 37 elements fabricated of mullite rods, 7.14 mm diameter. Based on the results, several correlations have been developed based on bulk freezing and heat conduction limited models.

56712 Variability of cladding deformation of LMFBR fuel elements. Hofman, G.L. (Argonne National Lab., IL (USA)). pp C4/5 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56713 Pipe whip analyses on the bundle tubes in a sodium - water steam generator. Janssen, L.G.J. (Stichting Energieonderzoek Centrum Nederland, Petten). pp F9/6 1-11 of Structural mechanics in reactor technology. Vol. F. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Neratoom B.V. was to prove that a fractured tube in sodium-water steam generators could not cause an adjacent tube to break due to mechanical interactions during the pressure peak of the sodium-water reaction. The determination of mechanical interaction between two tubes requires a very detailed dynamic analysis of global and local deformations. Up till now it is not possible to do such a detailed analysis completely by means of calculations unless at extremely high cost. Therefore, Neratoom B.V. decided to have calculations performed to determine the global deformations and velocities of the whipping tube and experiments carried out to investigate the local deformations at the point of impact of the adjacent tube. The maximum calculated kinetic energy of the tube at the potential moments of impact with an adjacent tube is used as an input parameter for the experiments. The deformation and velocity calculations of the whipping tube were performed at ECN using the finite element program MARC. The impact tests were carried out at the Materials Institute of TNO in Apeldoorn. The paper covers the ECN-calculations for two types of steam generators, a straight tube and helical-coil type.

56714 Analytical studies of a finite six-channel blockage in a LMFBR subassembly. Miles, K.J.; Ragland, W.A.; Marr, W.W. (Argonne National Lab., IL (USA)). pp C4/10 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56715 Effect of high external thermal loading on LMFBR subassembly integrity. Smith, J.L.; Helenberg, H.W.; Kilsdouk, D.J.; Pedersen, D.R.; Pierce, R.D.; Wilson, R.E. (Argonne National Lab., IL (USA)); Ariman, T. (Notre Dame Univ., IN (USA)). pp E3/9 of Structural mechanics in reactor technology. Vol. E. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56716 Three-dimensional non-linear failure analysis for PCRV's and containment structures. Reich, M. (Brookhaven National Lab., Upton, NY (USA)); Connor, J.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). pp H2/1 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56717 Stress analysis of a MCP pressure vessel nozzle. Andersen, S.I. (Research Establishment Risoe, Roskilde (Denmark)); Henriksson, T. (ASEA-ATOM AB, Vaesteraas (Sweden)); Reynen, J. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp G8/4 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this paper is to discuss the different stress analysis methods applied at various stages during design work on a complicated nozzle for a BWR-vessel, and to compare these methods which each other and with experimental results obtained from measurements on the vessel during proof testing. Conclusions are presented regarding the general approach applied and the validity of the different methods. These conclusions will be valid for components possessing some similarity with the present structure. The component dealt with is the nozzle for the main circulation pumps in the pressure vessel of the ASEA-ATOM BWR.

56718 Verification programme of tests and studies on Scandinavian BWR-PCRV. Menon, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)). pp H1/4 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The verification programme was the third phase of the development of PCRVs for BWRs in Scandinavia. The technical and economic feasibility of BWR-PCRVs was demonstrated in the earlier phases-as reported at the SMiRT-1 and SMiRT-2 conferences. As part of phase 2, a specification was made of a programme of further experimental and other verification considered necessary before a decision could be taken to build a BWR with a PCRV. Phase 3, the carrying out of this verification programme, has just been completed. A vessel design has been developed based mainly on techniques matured and experiences gained on PCRVs for GCR applications. The Asea-Atom BWR with internal pumps has been utilized with minimal changes from the standard steel vessel version. Above all, the safety-related tests and analyses of phase 3 have demonstrated the extremely high safety characteristics of the Scandinavian BWR-PCRV design.

56719 Thermal shock studies associated with injection of emergency core coolant in pressurized water reactors. Cheverton, R.D.;

Bolt, S.E.; Iskander, S.K. (Oak Ridge National Lab., TN (USA)). pp 9/3 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The LOCA-ECC Thermal Shock Program was established to investigate the potential for flaw propagation in pressurized-water reactor (PWR) vessels during injection of emergency core coolant following a loss-of-coolant accident. Studies thus far have included fracture mechanics analysis of typical PWRs, the design and construction of a thermal shock test facility, determination of material properties for thermal shock test specimens, and three thermal shock experiments. Experimental results obtained thus far tend to verify the linear elastic fracture mechanics methods of analysis applied to the thermal shock problem, and indicate that warm prestressing may limit the extent of crack propagation in those cases where initiation in PWR vessels is predicted.

56720 Assessment of the integrity of PWR pressure vessels - a U.K. study group report. Marshall, W. (UKAEA London Office). pp G6/1 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The main conclusions and recommendations of the UKAEA study group on PWR pressure vessel integrity are presented. The present paper summarizes a more comprehensive account of the work of the study group. This document reviewed the material properties and their variation, detailed the various reactor transient conditions and assessed a typical design against the possibilities of ductile and non-ductile failure. Critical crack sizes were assessed for all design conditions and special consideration was given to such reactor fault conditions as loss of coolant and steam-line break. A careful assessment was made of the rate of crack growth to be expected in service due to fatigue and corrosion effects. The role of the cold hydro pressure test in preventing vessels entering service with significant defects was discussed. The quantitative estimation of pressure vessel reliability is a problem in which account must be taken of the various material properties, crack sizes, and their variability.

56721 Experimental studies of PWR safety injection branch flow. Parras, F.; Dubourg, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)); Milan, D. (Ecole des Mines de Saint Etienne, Grenoble, France). pp B5/3 1-15 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The safety injection water, injected through the auxilliary piping in the primary circuit of pressurized water reactors, may be at a temperature significantly different from that of the primary fluid. Some fatigue analyses have shown that it is necessary to install thermal sleeves for protecting nozzles against cyclical thermal stresses. Moreover, the primary flow can induce vibrations at a level which can have a detrimental effect on the thermal sleeve. This paper shows the results of an experimental study performed by Framatome, which presents both the thermal efficiency and the vibration behaviour of thermal sleeves. Two reduced scale models (1/5) of a 12 inch size nozzle have been tested. One nozzle is perpendicular to the main circuit, the other inclined at 45°.

56722 Pressure induced stresses in the upper part of a PWR vessel, using photoelastic and 3D finite element methods. Robert, A.; Bourdon, C. (Service Technique des Coustructions et Armes Navales, 8, Boulevard Victor, F-75732 Paris Cedex 15, France); Baylac, G. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires); d'Escatha, Y. (Ministere de l'Industrie et de la Recherche, 75 - Paris (France)); Vagner, J. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). pp G7/3 1-20 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A three-dimensional finite element analysis of the stresses in the upper part of a PWR vessel would represent a formidable task. Thus, it is of common practice to carry out a separate analysis of the various items (flanges, nozzles, head...) and to use approximate modelling techniques to reduce the computational effort. By doing this, it is not possible to assess the stress concentration effects and to appreciate the interaction between two elements. The need for more complete studies is evident in order to provide guidelines for the methods commonly used in stress reports. A comprehensive study of the pressure induced stresses in the upper half of a 3-loop PWR vessel was undertaken to satisfy this need by using an epoxy 0.1 scale model. With this model it is possible to represent the six nozzles, the two flanges, the spherical head, the studs and the holes in the flange and in the head. Prestressing in the studs is obtained through the use of helicoidal springs. The experimental technique is the so-called 'frozen stress' method. The results are compared with those of a three-dimensional finite element analysis of the head submitted to the combined action of pressure and stud reaction in order to make an assessment of the computational stress intensification effects near the holes.

56723 Studies of overload behaviour of removable top closures of PCRV for light water reactors. Schimmelpfennig, K. (Consulting Engineers Prof. Zerna-Dr. Schnellenbach, Viktoriastrasse, Bochum, Germany, F.R.). pp H6/4 1-10 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Within the German research program on PCRV for light water reactors, sponsored by the Bundesminister fuer Forschung und Technologie, theoretical and parametric studies were done at the Institut fuer Konstruktiven Ingenieurbau, Ruhr-Universitaet Bochum. Part of this work was the development of a method for calculating ultimate load behaviour of PCRV, as described in SMiRT-3 paper H 4/6. In order to check the quality of the method a number of ultimate load calculations for vessels and vessel components with various shapes has been carried out. One is exemplary presented in this paper. It concerns a model of a removable concrete top closure, which has been developed by Fried. Krupp GmbH within the same research program. Two identical models were tested in order to study ultimate load behaviour. The shape of such a slab is characterized by a close fitting to the dome generated under internal pressure in the concrete continuum. No remarkable cracking could be observed during testing the models up to pressures of 450 kg/cm^2 and 550 kg/cm^2, respectively. The tests were ceased without reaching failure.

56724 Inelastic behaviour and failure mode of multi-cavity PCPV model for the three-loop helium high temperature turbine reactor. Garas, F.K.; Chalmers, A.G.; Fleischer, C.C. (Taylor Woodrow Construction Ltd., Southall (UK)); Rautenberg, J.; Schaeffer, K. (Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (Germany, F.R.)). pp H4/1 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A prestressed concrete pressure vessel has been developed for H.R.B. West Germany, to provide the primary containment for a fully integrated helium turbine reactor system. In this system the complete helium circuit consisting of the reactor, turbo-machinery, heat exchangers and gas ducts are integrated in the one vessel. Three horizontally mounted turbines, each connected to a recuperator, cooler and connecting gas ducts form a separate loop with one central reactor. This paper describes the experimental work undertaken on two 1/30th scale models of the proposed design, and compares the experimental findings with the predictions of a non-linear dynamic relaxation analysis. The models were constructed with all structurally significant details associated with the proposed design being accurately represented. In addition care was taken to ensure that the balance of prestress, reinforcement and pressure forces present in the prototype were maintained. Although principally concerned with non-linear behaviour, the paper includes a direct comparison between the linear behaviour of the two models and the predictions of a 3-dimensional finite element analysis used as the basis for the prototype design.

56725 Elastic and elastic-plastic buckling of vessel heads. Computation by the CEASEMT system. Canton, B. (Institut Universitaire de Technologie, F-00000 Cachan, France); Hoffmann, A.; Roche, R.L. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques); Troclet, C. (Ecole Nationale Superieure de Mecanique et d'Aerotechnique (ENSMA), 86 - Poitiers (France)). pp G7/4 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In Liquid Metal Fast Breeder Reactors of integrated type, the sodium pressure is low, but the dimensions are large. The thickness-diameter ratios are rather smaller than in other type of nuclear pressure vessels. Therefore buckling must be considered as a potential mode of failure. For instance, the bottom head of the main vessel is loaded by internal hydrostatic pressure and dead weight, and there is a need for buckling analysis. It must be pointed out that in practical cases, buckling occurs after plastic deformation. Due to the effect of initial imperfections elastic buckling is rather difficult to analyse. Moreover, elastic-plastic buckling theory is not a very clear theory and consideration must be given to finite deflexions (and

perhaps to initial stresses). So the choice of a suitable mathematical model is a matter of good engineering judgment. In the CEASEMT system of structural analysis by finite element method, a special program has been developed for that purpose. The model chosen (MOTAN) is near a tangent modulus model, because it seems a better approximation of the real behaviour of mechanical structures. The buckling load of shells of any shape can be predicted. The method is now operational but a validation program is still in progress.

56726 Thermal elasto-plastic analysis in reactor vessel nozzles. Cesari, F.; Gradari, P.L. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Programma Reattori Veloci); Curioni, S. (Bologna Univ. (Italy)). pp G9/8 1-8 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In a sodium cooled nuclear fast reactor the thermal analysis has a particular importance as a consequence of the rapid transients and the high sodium conductivity. The aim of this work is to estimate the value of transient thermal stresses in elastic and plastic fields. In the first part, the loading conditions for different steady and transient operations are examined. It is not easy to evaluate theoretically the temperature distribution in the vessel wall as a consequence of different core transients. For this reason, a number of tests have been placed, which simulate in a mock-up the temperature changes in the upper part of the vessel for different thermal transients considered most dangorous: scram to full power, electric supply fault in a pump with reactor scram, pump seizure with reactor scram. In the second part of the work the thermo-elastic structural response is considered using the FEM analysis. The elastic approach has had two functions: the first is to find a simplified structure in two dimensions that has the same behavior as the 3-D nozzle; the second is to follow the thermal transient to look for the time of maximum stress.

56727 Elastoplastic and nonsymmetric buckling analysis by finite element of Super-Phenix primary vessel head. le Guern, M.; de Rouvray, A.L. (Engineering System International S.A., 20, Rue Saarinen, G-94150 Rungis-silic, France); Gerij, M. (Compagnie d'Ingenierie pour les Reacteurs au Sodium (CIRNA), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Esztergar, E.P. (Consultant, 442 Westbourne Street, La Jolla, California 92037, U.S.A.). pp G7/5 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56728 Thermal ratchetting in pressure vessels. Tonarelli, L.C.; Ticozzi, C. (Nuclear Component Department, Breda Termomeccanica S.p.A., Viale Sarca, 336, I-20100 Milano, Italy). pp G9/6 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

During its lifetime a nuclear power plant undergoes cyclic thermal loadings, i.e. time variations of temperature spatial distribution; these thermal cycles combined with methanical loads (pressure), can produce dimensional changes for creep, plastic cycling and/or ratchetting. This problem is in special way important for a Liquid Metal Fast Breeder Reactor (LMFBR) because temperatures in it are high (about 500°C) and change either in radial direction or in axial direction. While the plastic behaviour of a structure subjected to mechanical loads and/or mechanical cycle loads can be well studied by Finite Element analyses and several different computer programs, the thermal plastic behaviour was studied for simplified conditions only. Actually, the Bree, Miller, Burgreen model considers a thin cylindrical shell with a radial thermal gradient and in uniaxial stress state while Kalnins, Updike extend this model to a biaxial stress state. To obtain numerical results of the thermo-plastic behaviour of cylindrical shells, a mathematical model was developed and the special purpose computer program PLAST was implemented.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 56321, 56756

MAGNETIC

REFER ALSO TO CITATION(S) 57490

COMPRESSED GAS

REFER ALSO TO CITATION(S) 56756

FLYWHEELS

REFER ALSO TO CITATION(S) 56220

THERMAL

REFER ALSO TO CITATION(S) 56320, 56322, 56323, 56863

56729 (ORNL—5485, pp 184-188) **Thermal energy storage: physical chemistry of phase-change materials.** Cantor, S.; Heatherly, D. Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

This research program has been concerned with the study of compounds and mixtures that store and discharge energy isothermally on melting and freezing and are suitable for applications (residential, commercial, industrial, and agricultural) up to 250°C. Two areas were emphasized: (1) study of the factors that affect the performance of incongruently melting salt hydrates (especially $Na_2SO_4.10H_2O$) as latent-heat storage media and (2) identification and evaluation of storage materials that melt in the range, 90 to 250°C. As noted previously, the differential scanning calorimeter (DSC) is an efficient and versatile tool for investigating thermal behavior of storage media. For incongruently melting hydrates, the DSC measured the differences between ΔH of fusion and ΔH of solidification and recorded how these enthalpies change upon thermal cycling. In evaluating organic materials melting between 90 and 250°C, DSC measurements of time- and cycle-dependent changes in ΔH of fusion were used to detect thermal decomposition. Although exothermic measurements also provide information about supercooling, the shallow-pan configuration of DSC samples seems to increase the extent of supercooling; therefore, supercooling was also studied by temperature-time plots on more massive samples.

56730 (STUDSVIK/EP—79/104) **Heat storage in rock cavities filled with fluid.** Westerberg, S. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Jan 1979. 36p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Heat storage in rock cavities filled with fluid was studied. In most of the computer calculations performed the storing fluid was oil in order to obtain results which could be directly compared to experimental data which mostly are taken from existing heated rock cavity stores for oil.

CHEMICAL

REFER ALSO TO CITATION(S) 56318, 56319

56731 (STUDSVIK/E—1-79/55) **System for heat storage in metal hydrides.** Dahlgren, T.; Lewis, D. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Mar 1979. 35p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Possible methods for the storage of heat are discussed, particularly thermochemical methods including metal hydride systems. For the metal hydride systems possible methods are described as well as existing experimental plants. Some possible future proects within this field are also summarized.

BATTERIES

REFER ALSO TO CITATION(S) 56254, 56872

DESIGN AND DEVELOPMENT

56732 (UCRL—82497(Rev.1)) **Aluminum-air power-cell system design.** Homsy, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Aug 1979. Contract W-7405-ENG-48. 6p. (CONF-790759—1(Rev.1)). Dep. NTIS, PC A02/MF A01.

From 1. international workshop on reactive metal-air batteries; Bonn, F.R. Germany (9 Jul 1979).

The reaction of Al with water and air in NaOh electrolyte is an electrochemical system that is being developed as a possible source of automobile propulsion. The net chemical reaction is $4Al + 6H_2O + 3O_2 \rightarrow 4Al(OH)_3$. The Al/air cell is a small part of a large power-cell system. The operation of the five subsystems that support the operation of the Al/air cell is described. A computer program

was written to calculate the flow rate, chemical composition, and temperature of each stream when given input parameters characteristics of the cell stack and crystallizer operating conditions and ambient conditions. Four parameters were varied to measure system response, and the results are shown. 5 figures, 2 tables. (RWR)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 56376, 56826

MATERIALS, COMPONENTS, AND AUXILIARIES

56733 (COO—4451-1) **Electrolytic degradation of lithia-stabilized β-alumina. Technical progress report, September 1, 1977-April 30, 1978.** Virkar, A.V. (Utah Univ., Salt Lake City (USA). Div. of Materials Science and Engineering). May 1978. Contract EG-77-S-02-4451. 38p. Dep. NTIS, PC A03/MF A01.

This report describes the research activities under DOE Contract No. EG-77-S-02-4451.A000 during the period September 1, 1977 through April 30, 1978. The report describes work in the following areas: purchase of necessary equipment; design, construction and operation of three cells - two for Na-Na tests using β-alumina electrolyte tubes and one for testing rectangular bar-shaped specimens with mercury and $NaNO_3$-$NaNO_2$, eutectic melt as the electrodes; fabrication of fine and coarse gained β-alumina specimens of bar and tube geometry. Fracture mechanical studies using the Knoop indentation technique; and preliminary cell testing results and evaluation of theoretical models. Some of the significant findings include the following: the Knoop indentation technique for controlled flaw initiation can be successfully used with β-alumina specimens of fine microstructure; the preliminary results obtained with the Na/β''-alumina/Na cells indicate that the temperature dependence of critical current densities for electrolytic degradation may be consistent with the prediction of the critical fracture model. 9 figures.

56734 **Lithium-aluminum-iron electrode composition.** Kaun, T.D. (to Dept. of Energy). US Patent 4,158,720. 19 Jun 1979. Filed date 28 Dec 1977. 8p.

PAT-APPL-865,164.

A negative electrode composition is presented for use in a secondary electrochemical cell. The cell also includes an elctrolyte with lithium ions, such as a molten salt of alkali metal halides or alkaline earth metal halides, that can be used in high-temperature cells. The positive electrode contains a chalcogen or a metal chalcogenide as the active electrode material. The negative electrode composition includes up to 50 atom percent lithium as the active electrode constituent in an alloy of aluminum-iron. Various binary and ternary intermetallic phases of lithium, aluminum, and iron are formed. The lithium within the intermetallic phase of Al_5Fe_2 exhibits increased activity over that of lithium within a lithium-aluminum alloy to provide an increased cell potential of up to about 0.25 volt.

56735 **Electrolyte composition for electrochemical cell.** Vissers, D.R.; Tomczuk, Z.; Anderson, K.E.; Roche, M.F. (to Dept. of Energy). US Patent 4,156,758. 29 May 1979. Filed date 9 Aug 1978. 6p.

PAT-APPL-932,153.

A high-temperature, secondary electrochemical cell that employs FeS as the positive electrode reactant and lithium or lithium alloy as the negative electrode reactant includes an improved electrolyte composition. The electrolyte comprises about 60 to 70 mole percent LiCl and 30 to 40 percent mole percent KCl, which composition includes LiCl in excess of the eutectic composition. The use of this electrolyte suppresses formation of the J phase and thereby improves the utilization of positive electrode active material during cell cycling. 1 table.

ENERGY MANAGEMENT AND POLICY

56736 (DOE/EIA—073/3-S2) **Annual report to Congress, 1978. Volume 3, Supplement 2. Midterm energy projections for the world.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 375p. Dep. NTIS, PC A16/MF A01.

This Energy Information Administration (EIA) report summarizes the basic assumptions and methodology that were used to generate the international energy forecasts presented in the 1978 Annual Report to Congess (ARC). Included as an appendix are the detailed reports of the International Energy Evaluation System (IEES), the computer model used by the EIA to provide worldwide estimates of energy supply and demand. An IEES report is included for each year/projection series combination analyzed in the 1978 ARC. The information provided is to be used as a supplement to the analysis presented in Chapter 2, Volume three of the 1978 ARC.

56737 (DOE/EIA—0173/3-S1) **Annual report to Congress, 1978. Volume 3, Supplement 1. Midterm energy projections for the United States.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 1023p. Dep. NTIS, PC A99/MF A01.

This EIA report is a summary of the key parameters, assumptions, and data inputs that were used to generate the 1985, 1990, and 1995 projections for the 1978 Annual Report to Congress. It includes a discussion of the projection series approach, overviews the modeling system, and presents the technical detail for the various series of energy projections. These projections are based on an assumption of continuing current energy legislation and a range of assumptions on future energy production, consumption, prices, and associated variables. The use of several different scenarios in making the projections is designed to reflect the inherent uncertainties in projecting energy supply and demand. Appendices include the complete computer printouts and maps.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 56736, 56737, 56747

56738 (CONF-790852—1) **Quantification of uncertainties in the parameters of a long-term energy model.** Peelle, R.W.; Downing, D.J.; Bjornstad, D.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From IGT symposium on energy modeling II: the interface between model builder and decision maker; Colorado Springs, CO, USA (13 Aug 1979).

Even if the form of an energy-economy model's equations can be assumed to specify correctly our technological processes and the relevant behaviors of our society over the necessary time range, there is uncertainty in model results induced by our imperfect knowledge of the numerical values of the model's parameters and input data. Some of this uncertainty is typically covered by provision of alternative scenarios with assumptions but, up to now, modelers have rarely dealt in detail with the inherent uncertainty of input data. However, when model output or response can be represented by a first-order Taylor expansion in the input data about the nominal solution point, knowledge of the variance-covariance (uncertainty) matrix of the input data is sufficient to determine the uncertainty in the computed response induced by the input uncertainties. Some guidelines are given for the evaluation of the required input-uncertainty matrices. Illustrative examples are given from the authors' beginning efforts to develop an uncertainty matrix for the important parameters of the Long-term Energy Analysis Package used within the Energy Information Administration of the Department of Energy.

56739 (ORAU/IEA—78-25) **Oak Ridge Associated Universities, Institute for Energy Analysis research report, 1978.** (Institute for Energy Analysis, Oak Ridge, TN (USA)). Oct 1978. Contract EY-76-C-05-0033. 35p. Dep. NTIS, PC A03/MF A01.

The annual report of the Institute for Energy Analysis (IEA) is presented. The IEA was established in 1974 to examine broad questions of energy policy. It assesses energy policy and energy research and development options and analyzes alternative energy supply and demand projections from technical, economic, and social perspectives. The IEA focuses primarily on national energy issues, but it is also concerned with international energy questions and their implications for domestic energy problems. Work was carried out in the following areas: solar and decentralized energy systems, nuclear energy studies, biological risks from energy technologies, carbon dioxide, conservation and cost analysis, fossil energy studies, economic analysis, net energy analysis, other studies and topics. Highlights in these areas are briefly summarized, and then abstracts of recently published documents are presented. (RWR)

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 56811, 56856

56740 (CONF-790864—1) **Financing community energy planning.** Clifford, D.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

From Community renewable energy systems conference; Boulder, CO, USA (20 Aug 1979).

Energy planning is a new element in community planning that has evolved as abundant sources of cheap energy (or fuel) become less available. Successful energy planning depends on the ability to organize and to plan for energy management at the local level. This paper demonstrates some of the opportunities and methods that the Comprehensive Community Energy management communities have used to supplement their energy planning budgets. CCEMP is a two-

year, DOE-funded pilot effort involving 17 communities to determine capabilities and programs to organize and to plan energy conservation and management at the local level. CCEMP communities have leveraged available DOE funds with cash, in-kind non-cash contributions, and CBDG funds. Economic Development Administration, 701, 208, and other Federal programs have provided information essential to the process. Private funds also are used. The Farmers Home Administration with DOE cooperation provides a small-scale energy planning pilot for smaller communities. Energy boom town legislation has been proposed, as well as new legislation that would provide additional funding for local energy planning.

56741 (COO—4287-15) **Mapping Project on Energy and the Social Sciences. Progress report, October 1, 1978-June 30, 1979.** Walker, C.A.; Doob, L.W.; Gould, L.C. (Yale Univ., New Haven, CT (USA). Institution for Social and Policy Studies). 1979. Contract EE-77-S-02-4287. 27p. Dep. NTIS, PC A03/MF A01.

This is a progress report of activities in the fourth year of the Yale Institution for Social and Policy Studies Mapping Project on Energy and the Social Sciences. The Mapping Project evaluates past and present social and behavioral science energy studies, assesses the potential for social and behavioral science contributions to a resolution of the energy problems in the future, and diffuses social and behavioral science information and perspectives to policymakers and others concerned with US or world energy developments. Activities in FY 1979 included meetings, workshops, collecting bibliographic material, publications, evaluating DOE programs in buildings and transportation, performing a special study of potential social impacts of 4 coal technologies, and developing plans for 10 specific research studies on energy.

56742 (DOE/TIC—10233) **Facility siting and managing energy impacts in New Mexico.** (Resource Communities, Inc., Santa Fe, NM (USA)). Sep 1977. 88p. Dep. NTIS, PC A05/MF A01.

The development of western energy sources depends on the proper management of social, economic, and environmental impacts in cooperation with state and local officials. Environmental protection standards are well established but socio-economic impact standards are not. Consequently, these issues dominate most state siting-permit hearings. The energy-facility siting experience in Wyoming and components of a siting process in New Mexico are discussed for comparative evaluations. This report offers a solution based on improvements in sharing information and financial risk among the interested parties. The comparison leads to conclusions followed by recommendations for immediate action.

56743 (DSD—90) **Regional employment and income effects of a 50-MW wood-fired power plant.** VanderWerf, P. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Aug 1978. Contract EG-77-C-02-4487. 49p. Dep. NTIS, PC A03/MF A01.

Construction and operation of a 50-MW wood-fired power plant could have a profound influence on the rural region in which it is located. Using Department of Commerce regional data, input-output computer analysis techniques are employed to estimate the effects on local income and employment of constructing and operating such a plant in a three-county region in northern Vermont. In general, the result was a total new annual income for local industries of about double the plant's yearly outlay. The increase in local income also created new jobs; regional unemployment rates could theoretically drop about one-half of one percent because of the plant's presence. Because most of the plant's expenditures in the three-county region will be for labor, the industries that profit most from its spending will be the retail, wholesale, food, and apparel businesses, which depend on individual consumer sales. These businesses are likely to suffer a mild recession after the relatively intense two-year construction phase, as operation-phase annual expenditures are substantially lower than construction phase levels and require fewer workers. However, with proper planning, regional businesses and individual workers should be able to benefit substantially from both phases of the plant's activities.

56744 (IES—83) **Low-energy scenario for the United States: 1975-2050.** Steinhart, J.S.; Hanson, M.E.; DeWinkel, C.C.; Gates, R.W.; Briody, K.A.; Thornsjo, M.D.; Kabala, S.J. (Wisconsin Univ., Madison (USA). Inst. for Environmental Studies). Jul 1977. 41p. Univ. of Wisconsin, 610 Walnut, Madison, WI.

A 64% reduction in per capita energy use is projected for year 2050 in the United States with no drastic change in the standard of living but with minor changes in social and physical institutions, economic patterns, and the distribution of work, leisure, and income.

56745 (PB—289624) **Capital requirements and capital formation for various assumed US energy supply patterns.** Deonigi, D.E.; Broehl, J.H.; Foley, T.J.; Rao, S.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1976. 166p. NTIS PC A08/MF A01.

A study was made to determine the probability and magnitude of the predicted shortage of capital in an economy supporting development of alternative energy supply systems. A modified version of EXPLOR MULTITRADE-85, a mathematical model for medium- to long-range forecasting of entire economies, was used. The objective was to quantify the potential capital shortfall under the scenarios of (1) meeting increased energy demand by business-as-usual development of existing resources and by importation, (2) introducing new technology to meet 7% of certain energy requirements by 1990 and 10% by the year 2000, and (3) introducing new technology to meet 5% of certain energy requirements by 1980, 10% by 1990, and 15% by the year 2000. (Portions of this document are not fully legible)

56746 (PB—289693) **Request for proposal under the Community Energy Conservation Grant Awards Program. Report for 18 August 1978-16 October 1978.** (Illinois Inst. of Natural Resources, Springfield (USA) Energy Conservation Div.). 18 Aug 1978. 23p. NTIS PC A02/MF A01.

This report is a request for proposals from municipalities to receive a one-time grant to support energy conservation activities at the local level. This Grant Awards Program is presently a one-time program offered as a part of the Illinois Energy Conservation Program; applications must be completed by October 16, 1978.

56747 **Dollar, energy, and employment costs of protein consumption.** Hannon, B.M.; Harrington, C.; Howell, R.W.; Kirkpatrick, K. (Univ. of Illinois, Urbana). *Energy Syst. Policy;* 3: No. 3, 227-241(1979).

The dollar, energy, and the labor costs of producing beef and soy protein were computed and compared using input-output analysis. Production costs of both beef and soy protein in various forms were examined in detail from the farm to the consumer. A complete soybean meat substitute is one-sixth as energy-intensive and one-sixth as expensive as beef raised in the Corn Belt region, and direct soybean consumption is one-ninth as energy-intensive and one-tenth as expensive as beef. Beef, however, is less energy-intensive than the average of consumer activities. Thus, if the dollar savings realized by a shift from beef to a soybean meat substitute were allocated to average consumer spending, there would be no energy saving from the shift, and there could even be a small increase in energy demand. 15 references.

56748 **Financing of the investments made by the electricity industry in particular - a bottleneck.** Radtke, G. pp 109-114 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 4: Restriktionen. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

Several basic problems concerning capital investment in the energy sector are discussed and the financing regulations of the Federal Insurance Board are explained. Finally, the author goes briefly into detail as far as a modern form of financing is concerned namely 'leasing'.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 56211, 56212, 56775, 56776, 57096, 57107, 57110, 57192

56749 (DOE/TIC—10114/2) **Regional environment-energy data book: western region.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1978. Contract W-7405-ENG-48. 442p. (LBL—7821). Dep. NTIS, PC A14/MF A01.

This document provides a compilation of regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the West. Its intended uses are to provide data for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantity; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

56750 (DOE/TIC—10114/3) **Regional environment-energy data book: northeast region.** (Brookhaven National Lab., Upton, NY (USA)). Dec 1978. Contract EY-76-C-02-0016. 715p. (BNL—24867). Dep. NTIS, PC A99/MF A01.

This document provides a compilation of regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the Northeast. Its intended uses are to provide for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in analyses and studies; provide a reference book that can be used by local groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and, energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantity; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

56751 (DOE/TIC—10114/5) **Regional environment-energy data book: northwest region.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1978. Contract W-7405-ENG-36. 849p. (PNL-RAP—28). Dep. NTIS, PC A99/MF A01.

This document provides a compilation of regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the Northwest. Its intended uses are to provide data for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in analyses and studies; provide a reference book that can be used by local groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantity; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 57123

56752 **Energy self-sufficiency for the County of Kauai. Volume 1. Energy data.** Kai, K.; Nakamura, M.; Seki, A.; Takahashi, P.K.; Yuen, P.C. Manoa, HI; Hawaii Natural Energy Institute (1979). 44p. (HNEI—79-01). Hawaii Natural Energy Inst., Manoa, HI.

Kauai County, Hawaii is heavily dependent on petroleum products, with electrical generation and ground transportation being the chief consumers of petroleum. Indigenous energy resources, however, account for more than 50% of all energy consumed in the County, bringing Kauai closer than any of the other Counties to the goal of energy self-sufficiency. With carefully planned, appropriate, and expeditious development of available natural energy resources, and with an effective energy conservation program, the goal of energy self-sufficiency should be well within the reach of Kauai County.

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 56852

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 56087, 56115

56753 (GRS-S—21) **Comments on topical questions of nuclear energy. Selection of statements by the Federal government. 7th legislative period 1972/1976.** Butz, H.; Noll, M. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching (Germany, F.R.)). May 1978. 617p. (In German). Dep. NTIS (US Sales Only), PC A99/MF A01.

During the 7th legislative period (1972/76) of the German Bundestag the Federal Government has repeatedly commented on questions concerning nuclear energy. The present documentation comprises a selection of the most important issues. The collection contains in particular: written and oral answers of the Federal Government to written or oral questions of members of parliament; answers of the Federal Government to major and minor interpellations of fractions or factions; statements of the chancellor, the ministers and permanent secretaries; bills of the Federal Government if they were issued as parliamentary documents or as plenary minutes. The main attention when selecting the documents was drawn to giving complete recording of the statements on the safety of nuclear plants and on radiation protection. Furthermore, the comments on questions concerning nuclear energy were considered both in general and in connection with alternative energy sources. Eventually, the general situation concerning energy could be verified. The selection of documents has certainly not thoroughly remained uninfluenced by subjective decisions. The parliamentary documents and plenary minutes given here are recorded by chronological order. An index of subject headings will facilitate access to all documents. (orig.) 891 HP.

56754 (Juel-Spez—11) **Uses and examples of application of nuclear power in North Rhine-Westphalia with special regard to its contribution to a structural improvement.** Jehle, B. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; Bochum Univ. (Germany, F.R.)). Jun 1978. 351p. (In German). Dep. NTIS (US Sales Only), PC A16/MF A01.

Thesis.

As examples of the implementation of nuclear energy, the alternative potentials for meeting electricity demand and for coal gasification in North Rhine-Westphalia have been studied, with particular applications in the chemical and iron and steel industries of this state. The effects on competitiveness and choice of sites for these industries and on hard coal production have been quantified. The political significance of implementing nuclear energy for improving the economic structure depends not only on these individual economic effects but also on the contribution to growth and the effects which spread from these industries throughout the whole regional economy, which have also been quantified. The development of the chemical, iron and steel and coal industries can affect over 30% of the entire labor force of North Rhine-Westphalia; thus for these industries energy-economic forces have appreciable structural effects.

56755 **Benefits and risks of energy supply with special regard to nuclear energy.** Gruemm, H. pp 91-97 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 4: Restriktionen. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

In a comparative evaluation the attempt is made to compare environmental loads and risks on the basis of cost evaluation with the use of the comfort-energy electricity, resulting in a critical discussion of those facts whose emotional interpretation has lead to restirctions in energy supply. Limits are shown emerging when consequences affecting the individual are included in a comparative evaluation.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 56817

56756 (NP—23920) **Inventory of underground energy storage sites in California.** (California Energy Resources Conservation and Development Commission, Sacramento (USA)). Oct 1978. 89p. NTIS, PC A05/MF A01.

This report provides information on potential underground energy storage sites in California. Most of this data was collected as part of an investigation of the feasibility of underground storage of compressed air for electricity generation, but many of the sites identified may be equally or better suited to other energy storage applications at a variety of sizes. Six types of potential storage sites in California are included in the data sheets of this report: gas fields, oil fields, saline aquifers, hard rock sites for the excavation of new reservoirs, caves, and abandoned mines. The information for each site, as appropriate for a given site type, includes the site name, location (county, city, USGS quadrangle), depth to storage medium, volume, rock type, rock thickness, permeability, porosity, pressure containment capability, and distance to transmission facilities, pipelines, and geologic hazards. The voltage of the nearest transmission line or substation is also indicated for each type of site, based on the map, Electric Generating Stations, Transmission Lines and Interconnecting Systems, 1967, compiled by the California Public Utilities

Commission. Each type of storage site and the methods for obtaining data specific to each site type are described.

56757 (SAND—78-8181) **Transmission of energy by open-loop chemical energy pipelines. Final progress report, May 1, 1977-January 31, 1978.** (Institute of Gas Technology, Chicago, IL (USA)). Jun 1978. Contract EY-76-C-04-0789. 226p. Dep. NTIS, PC A11/MF A01.

This report presents the results of a technical feasibility and economic viability analysis of the transmission of energy by open-loop chemical energy pipelines, in which hydrocarbons are supplied at the heat source and heat and SNG are produced for end-use at the methanator site. Three open-loop systems have been evaluated: a base case of an HTGR supplying heat for the steam reforming of methane, and a 161-km (100-mile) pipeline transmitting the reformed gas to a methanator producing steam and SNG; a near-term case with the HTGR/reformer replaced by a coal gasification plant producing carbon monoxide and hydrogen; and a mid-term version in which the HTGR/reformer is supplied with hydrocarbons by a LNG receiving terminal on a floating platform 3 miles or less off the US coastline, with an undersea pipeline connecting the complex to the shore. The open-loop chemical energy pipeline is technically feasible. No major problems were found in mating the various components of the systems designed. Existing natural gas transmission systems could potentially be converted for use as part of a chemical energy pipeline. Transmission of coal synthesis gases over long distances is more economically attractive than the shipment of coal by rail. Ample markets exist for the process steam, electricity, and SNG products from the system. The base case design did not produce product prices that were competitive, either now or in the near future. Product prices calculated for the near-term case may be competitive currently and would almost certainly be attractive in the immediate future. The mid-term design, while not producing product prices competitive now, could be economically viable in the 1980 to 1990 time frame.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 56863

56758 (CONS—5152-T1) **Evaluation of potential for cogeneration of electricity and process heat in North Carolina. Final report, June 1, 1978-May 31, 1979.** (North Carolina State Univ., Raleigh (USA). Dept. of Nuclear Engineering; Research Triangle Inst., Research Triangle Park, NC (USA). Center for the Study of Social Behavior). 1979. Contract EM-78-S-01-5152. 133p. Dep. NTIS, PC A07/MF A01.

The objective of this study was to enable North Carolina to more efficiently utilize available energy than would be possible without additional cogeneration. Effective use of cogeneration can ease the requirement for utility capital and power plant sites and, by reducing fuel usage, can lead to less environmental damage. The study used the National Emissions Data System data bank and the North Carolina Boiler Registry to identify potential candidates for cogeneration and to then ascertain the magnitude of the potential in existing, new, and expanded facilities as a function of cogeneration impediment elimination. The survey uncovered 372 MW of operable cogeneration capacity in North Carolina in 15 plants. An estimate of the potential for expansion of cogeneration by firms presently operating in North Carolina amounted to 130 MW. This estimate was based on current conditions of fuel costs, electricity rates, standby charges, and investment tax credit. Much information is provided concerning industry and utilities in North Carolina, fuel usage by industry, and barriers to cogeneration. Recommendations are summarized.

CONSERVATION

REFER ALSO TO CITATION(S) 56812, 56816, 56818, 56833, 56834, 56837, 56839, 56840, 56841, 56843, 56844, 56845, 56846, 56850, 56859

56759 **Louisiana Energy Conservation Plan 1979 (Public Law 94-163).** Baton Rouge, LA; Department of Natural Resources (1979). 217p. (NP—23980). Dept. of Natural Resources, Baton Rouge, LA.

This third-year State Energy Conservation Plan is the result of the experience and knowledge gained through the implementation of the first two plans. The plan contains the five program measures designated as mandatory (thermal and lighting efficiency standards, lighting efficiency standards, energy efficiency procurement, carpool/vanpool promotional program, right turn on red after stop) programs in PL 94-162 and eleven state-selected program measures. Estimated savings of Louisiana's energy conservation effort will exceed the minimum goal of a 5% reduction in the projected 1980 energy consumption for the state.

56760 (NP—23981) **Louisiana Supplemental Energy Conservation Plan. Second year supplemental plan.** (Louisiana Dept. of Natural Resources, Baton Rouge (USA)). 1978. 72p. Louisiana Dept. of Natural Resources, Baton Rouge, LA.

A State Energy Conservation Plan for Louisiana prepared to meet DOE guidelines for participation in the energy conservation legislation under U.S. Public Law 94-163 is presented. Some data forms, budgetary information, and regulatory and legal information are first presented. Following an overview of the Louisiana plan, information covered includes the proposed Louisiana energy conservation goal; environmental residuals statement; management plan; plan summary; and description of the program measures. Program measures discussed are: building energy audits (evaluation of state buildings); education and public awareness; intergovernmental coordination; and state supervision, implementation, and contract administration. The estimated reduction in environmental residuals that will result from implementation of the Louisiana Energy Conservation Plan is based on changes in energy use by primary fuel type. Total estimated energy savings are 220.98 trillion Btu's. This amount has been prorated to fuel types according to the mix of fuels used in the sector in which energy savings will occur. A summary of this distribution is presented in an appendix.

56761 (NP—23982) **Louisiana Energy Conservation Plan. Second year base plan.** (Louisiana Dept. of Natural Resources, Baton Rouge (USA)). Sep 1978. 211p. Louisiana Dept. of Natural Resources, Baton Rouge, LA.

A State Energy Conservation Plan for Louisiana prepared to meet DOE guidelines for participation in the energy conservation legislation under U.S. Public Law 94-163 is presented. Some data forms, budgetary information, and regulatory and legal information are first presented. Following an overview of the Louisiana plan, information covered includes the proposed Louisiana energy conservation goal; environmental residuals statement; management plan; plan summary; and description of the program measures. Measures described are: Thermal and Lighting Efficiency Standards for New Buildings; Lighting Efficiency Standards for Existing Buildings; Energy Efficiency Procurement Practices in State Government; Carpool-Vanpool Promotional Program; Right-Turn-On-Red After Stop; Repeal of Natural Gas Tax Credits; Residential Energy Conservation; Industrial Energy Conservation; Municipal Utilities Assistance; Industrial (Non-Manufacturing) Technology Transfer; Recycling of Paper and Aluminum; Energy Savings Evaluation Model; Drivers' Education and Vehicle Maintenance and Youth and Energy; Energy Conservation Promulgation Traveling Display; Thermal-gram Evaluations; and State Supervision, Implementation, and Contract Administration. Specifics on reduction in environmental residuals that will result from implementation of the Louisiana Energy Conservation Plan based on changes in energy use by primary fuel type are presented in an appendix.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 56048, 56736, 56737, 56745, 56755, 56778, 56783, 56813, 56814

56762 **Swedish energy supply 1977-1983.** Stockholm, Sweden; National Swedish Industrial Board (Feb 1979). 122p. (In Swedish).

This report from the National Swedish Industrial Board gives a prognosis of the Swedish consumption and supply of energy for the period 1977-1983. In 1977, energy import represented 17 per cent of Sweden total imports of goods, and this high dependence on imported primary energy, about 80 per cent, will remain through the period. A certain redistribution of the relative shares of the different energy sources is expected, viz. a slight decrease of the dependence of petroleum products and an increase of nuclear power.

56763 (INIS-mf—4766) **Corporate plan 1978. A summary of the outcome of the planning processes.** (Central Electricity Generating Board, London (UK)). Apr 1978. 55p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The CEGB Corporate Plan is intended as a background document for those in the industry and as a basis for discussions with the Department of Energy on investment programmes and energy policy generally. It contains the most recent information on actions taken or agreed, on remaining problems and an options for further action on these problems. Following an introduction summarising the CEGB's objectives and recent progress the issues are discussed under the following main headings: energy policy background; medium term plans; the year ahead; options, actions and conclusions. Appendices include: three energy scenarios, one a reference case by the Department of Energy, and two CEGB scenarios which identify a credible range of future electricity demands; 1978 capital investment proposals; and medium term forecasts for demand and plant

position at winter peak, and for bulk costs and unit sales. The board intends to continue to develop a suitable long term nuclear strategy which includes thermal reactors and the development of the fast reactor as a viable option.

56764 (NP—23912) **Natural gas supply and demand for California 1978-1995. Appendix C. Displacement of natural gas use through solar thermal applications: estimated residential gas demand savings in California from the use of solar water and space heating 1979-1990. (Corrected version).** (California Energy Commission, Sacramento (USA)). 15 Mar 1978. 84p. NTIS, PC A05/MF A01.

Most forecasts of natural gas demand do not adequately reflect the potential of alternative energy sources, such as solar energy, to reduce gas demand. This analysis provides estimates of solar energy's penetration into the residential gas water and space heating markets. The effect of increased utilization of solar energy on residential and total demand for natural gas is estimated for two policy options within the framework of the forecast developed by the Commission's Energy Assessment Division. A conservative estimate was made of the proportion of the gas demand projected for residential water and space heating which can be displaced by solar systems, for the years 1978 to 1985 and 1990. Solar market penetration was simulated for two government policy options: a tax incentive scenario and a mandating scenario. Conservative savings of 2 to 4% of forecasted 1985 residential gas demand, and 6 to 9% of 1990 residential demand were found.

56765 Entwicklung des energiebedarfs und moeglichkeiten der bedarfsdeckung. Grouppe 5. Moegliche zukuenftige entwicklung des bedarfs. (Development of energy demand and possibilities of supply. Group 5. Possible future development of the demand). Duesseldorf, Germany; VDI-Verl. (1977). vp. (CONF-771271—; AED-Conf—77-544-000).

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

A separate abstract was prepared for each individual paper. (RCK)

56766 Government analyses of energy supply and demand: a review. Just, J.; Lave, L. *Energy Syst. Policy;* 3: No. 3, 271-307(1979).

This article reviews and compares the scenarios and results from six major energy studies by the Federal government: Project Independence, the Energy Information Administration's Annual Report - 1977, the National Energy Plan, the National Energy R & D Plan, the Market Oriented Program Planning Study, and the inexhaustible Energy Resources Planning Study.

56767 Forecasts of the energy requirements in the FRG until 1990. Liebrucks, M. pp 123-126 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 5: Moegliche zukuenftige Entwicklung des Bedarfs. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

Based on facts dating back to 1970, as well as on the basic guidelines of the energy programs set up by the Federal Government, an attempt is made to set up a forecast broken down to consumer groups and energy sources, concerning energy consumption in the FRG until 1985. As projection to subsequent dates concerning the energy programs of the Federal Government, this forecast is extended to the period up to 1990. Estimations had to be based on today's viewpoints and can - of course - be modified by means of changes in energy policy particularly with regard to the power plant capacities installed, to service life and to the gross electricity generation broken down to energy sources. The possibly strongest influence may come from the utilization of nuclear energy because in this respect a series of questions still remain open (e.g. reprocessing, waste management, social acceptance).

56768 Determination of energy requirements and supply of needs - methods and results. Schmitz, K.; Rath-Nagel, S. pp 115-122 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 5: Moegliche zukuenftige Entwicklung des Bedarfs. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

Studies on systems analysis in the energy sector are described. A model system is explained, by means of which various strategies are simulated, taking into account all energy conversion processes conceivable today, concerning energy requirements and energy supply. The period covered ranges from now to the year 2010.

56769 Opportunities for substitution in energy supply. Voss, A. pp 157-164 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 6: Moeglichkeiten der zukuenftigen Bedarfsdeckung. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

Substitution processes developed in the past are described, and the function of energy prices is discussed. The energy sources petroleum, natural gas, coal, brown coal, and nuclear energy are examined with regard to respective reserves and to the opportunities involved relating to energy supply. The resulting possibilities for substituting energy sources are limited by the limited availability of primary energy sources. This margin could only be enlarged by a demand in energy lower in total. The substitutional potential of regenerative energy sources is - projected to the year 2000 - more than one power of ten below the substitutional potential of other energy sources. Solar energy cannot be regarded as a real alternative to nuclear energy.

56770 Primary energy sources for electricity supply in the FRG - demand and requirements as seen by the electricity supply industry. Bierhoff, R. pp 67-74 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 3: Gegenwaertige Bedarfsdeckung und ihre Systeme. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

Starting from the present energy supply situation in the FRG, the attempt is made to elucidate basic tendencies for its development until 1990. The author pleads for the necessary growth by means of a series of theses. The supply with electric power being in the foreground can only be secured in the long run by means of greater utilization of coal and nuclear energy. Due to costs, other energy sources - playing a major role - will contribute less to the supply of electric power.

56771 Securing of energy supply in the FRG. Geberth. pp 191-195 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 7: Energiewirtschaftliche Aspekte. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

After having made some introductory remarks on the embedding of energy policy in the overall framework of economic policy, it is explained how energy programs and energy forecasts can push developments. The basic guidelines of the energy policy set up by the Federal Government are described.

56772 Development of energy requirements in the FRG with regard to rational energy supply. Maier, W. pp 131-138 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 5: Moegliche zukuenftige Entwicklung des Bedarfs. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

A survey is given on the results of the study 'technologies for saving energy' elaborated in charge of Fichtner engineering consultants Stuttgart by order of the Federal Ministry for Research and Technology, from 1973 to 1976. An explanation of methodics is followed by a presentation of study results and the respective conclusions are drawn. The forecasts set up cover a period ranging from now up to the year 2000.

56773 Fostering technologies designed for a long-term energy supply and demand development. Schmidt-Kuester, W.J.; Wagner, H.F. pp 197-201 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 7: Energiewirtschaftliche Aspekte. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

As the discussions of options for the beginning of the next century shown, primarily coal and nuclear energy - utilizing the fast breeder reactor - are available apart from the dwindling reserves in petroleum and natural gas. Then there is solar energy - with a potential distinctively smaller - and in the very long run controlled nuclear fusion with a large potential. This balance sheet shows that we dont have as many options as that for securing the energy supply of future generations. Furthermore, it shows that in the long run coal and nuclear energy will not be competitors but will become the decisive support on which our energy supply will be based.

56774 Consequences of a long-term worldwide development in the energy industry to the energy supply of the FRG. Schmitt, D. pp 183-189 of Entwicklung des Energiebedarfs und Moeglichkeiten der Bedarfsdeckung. Gruppe 7: Energiewirtschaftliche Aspekte. Duesseldorf, Germany, F.R.; VDI-Verl. (1977). (In German)

From Congress on the development of energy demand and possibilities of supply; Berlin, F.R. Germany (5 Dec 1977).

An estimation of the development of energy consumption in the FRG is given to the year 2000, broken down to quantities, consumption sectors and energy sources. Even in the future a heavy import dependence in the energy sector will prevail for the FRG. Nobody in the world expects energy reserves to run out in the near future. Morerover, the problem consists in tapping reserves in time

and in restructuring the supply system from scarce to energy sources less scarce. The development of the international petroleum production estimated on certain suppositions (until 2025) will - in the long run - result in a shortage. This worldwide tendency and the specific supply conditions prevailing in the FRG indicate it appears advisable to direct the energy policy of the FRG towards the options coal and nuclear energy.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 56749, 56750, 56751, 56763, 56765, 56771, 56799, 56807

56775 (DOE/TIC—10114/4) **Regional environment-energy data book: southern region.** (Oak Ridge National Lab., TN (USA)). Dec 1978. Contract W-7405-ENG-26. 854p. (ORNL—5443). Dep. NTIS, PC A99/MF A01.

This document provides a compilation of regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the South. Its intended uses are to provide data for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in analyses and studies; provide a reference book that can be used by local groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantiy; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

56776 (DOE/TIC—10114/6) **Regional environment-energy data book: midwest region.** (Argonne National Lab., IL (USA)). Dec 1978. Contract W-31-109-ENG-38. 870p. (ANL/EES-TM—25). Dep. NTIS, PC A99/MF A01.

This document provides a compilation of regional data relating to the energy, environmental, socioeconomic, and institutional characteristics of the Midwest. Its intended uses are to provide data for policy analysis and generic impact assessments; assist the labs in developing relevant data to be used in analyses and studies; provide a reference book that can be used by local groups and institutions; and identify the gaps in regional data bases so that the Department of Energy (DOE) may be better able to allocate resources for data and program development. The document is divided into four chapters. Chapter I includes current and historic data on energy supply, demand, and production; sector fuel demands, fuel consumption, transmission, and transportation; location of energy production and conversion; and energy prices by sector and state. Chapter II shows a variety of natural and preternatural characteristics including water quality and quantity; air quality and air quality control areas; natural and induced climatic conditions; waste disposal; land and coast conditions, use, and management; managed and endangered species; demographic and socioeconomic conditions; and health and mortality data. Included in Chapter III are a variety of organizational, legislative, and regulatory data. Chapter IV provides energy equivalents, metric conversions, an index, and a glossary.

56777 **National Energy Policy Issues.** Austin, TX; University of Texas (1979). 292p. (NP—23939).

The Council on Energy Resources at the University of Texas conducted an objective analysis of current national energy policy issues, with particular regard to the President's energy proposals of April 1979. A summary document, National Energy Policy Issues, and 10 additional papers are presented. The additional papers are: The Role of Conservation in the National Energy Plan: A Review; Anticipated Revenues and Production Responses from Decontrol of Oil Prices; The President's Energy Program of April 5, 1979, and the Role of Natural Gas; Coal Problems and Prospects; Commercial Nuclear Power Generation; Production of Energy Resources from Federal Lands; Analysis and Evaluation of Oil Deregulation and Conservation--The Need for a New Energy Development Entity; The Accelerated Commercialization of New Energy Sources and Technology: The Development Bank Alternative; Coal Gasification and Liquefaction; Synthetic Rubber--A Case of Accelerated Technological Development. (MCW)

56778 **National Energy Policy Issues.** Austin, TX; University of Texas (1979). 55p. (NP—23937).

The paper analyzes energy proposals under debate at the time, presents various policy options available, and presents some recommendations for dealing with the energy problem. The radical reduction of US oil imports became more urgent in May 1979 than it was in April 1977, when President Carter launched his National Energy Plan proposals, for two reasons. First, total US energy production stagnated over the 2-year period even though North Slope oil added a flow of 1.2 Mbod to the nation's production. Second, the prospects for future OPEC production capacity were reduced below levels anticipated in 1977 through the direct and indirect effects of the Iranian crisis. The discussions center on the President's energy proposals in general, short-run measures to reduce oil imports, oil prices and production prospects, accelerated natural gas deregulation, nuclear problems and prospects, coal problems and prospects, energy-environmental issues, and the accelerated commercialization of new energy sources and technologies.

56779 **National Energy Policy: an interim overview.** Austin, TX; University of Texas (1977). 78p. (NP—23967).

The Council on Energy Resources undertook a research program to investigate energy policy issues facing the nation. This interim overview contains some of the principal findings. The findings are taken from the following papers: Present Status of National Energy Plan Legislation; Problems of Energy Production (Oil and Natural Gas Production, Projected Shortfalls in US Energy Production); US Oil and Gas Reserve-Resource Base; Summary: US Oil and Gas Reserves and Resources; Problems of Coal Utilization; Problems of Nuclear Energy Production; Future Energy Needs (Post-1985 Technologies, Energy Resources of the Federal Estate); Regional Equity in Energy Production and Consumption; Energy Production and Utilization: the International Situation.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 56788, 56789, 56790, 56791, 56792, 56793, 56796, 56797, 56798, 56799, 56800, 56801, 56802, 56804, 56805, 56806

56780 (CONF-7810176—, pp 87-96) **Fuels research & development for army weapon systems.** LePera, M.E. (Army Mobility Equipment R & D Command, Fort Belvoir, VA). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Automotive gasoline, jet turbine fuel, and diesel fuel are the primary fuels used by the US Army's mobile equipment. When materiel and equipment are modified or new powerplants are developed for specific weapon systems, research is conducted early in the process to be sure the fuel requirements can be met. The process begins with fuel characterization and compliance with specifications. Laboratory component testing is done to confirm those qualities which are identified as least crucial to output efficiency, followed by full-scale dynamometer and long-term durability testing. The major fuel requirements are commonality of fuels, survivability, and stability. Other requirements specify minimum operating temperature limitations, fuel additive restrictions and requirements, combustion efficiency, and variable quality properties.

56781 (CONF-7810176—, pp 163-185) **Production of liquid fuels from oil shale.** Alley, S.K. (Union Oil Co. of California, Brea). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

An overview of oil shale resources, retorting concepts, and refining technologies indicates that, while oil shale is a significant resource, Union Oil Company's prototype plant demonstrates that the industry is not ready to assume commercialization. Four retorting processes now under consideration are the Petrosix process, Paraho kilm, Tosco II process, and the Union Oil Company's upflow of solids. Refining techniques are being developed for the removal of solids and arsenic as well as for hydrotreating to reduce nitrogen content. Several other schemes are outlined for upgrading raw shale, the choice of scheme depending on the intended use of the finished fuel. A political atmosphere conducive to this type of development is necessary before shale oil can become competitive.

56782 (NP—23927) **California clean fuels study.** (Little (Arthur D.), Inc., Cambridge, MA (USA)). 1979. 112p. Arthur D. Little, Acorn Park, Cambridge, MA.

The Clean Fuels Study attempted to ascertain the price and availability of certain clean fuels to industrial and utility consumers in California over the period to the year 2000. The use of clean-burning fuels will be an alternative in many circumstances to installation of expensive post-combustion cleanup equipment. Thus, a knowledge of likely costs and availability of selected clean fuels will assist in regulatory and policy planning. Electric utilities are plan-

ning new or modified generating facilities based on oil-fueled burners. In deciding whether or not to authorize such facilities, California authorities require a forecast of availability of the requisite fuel and the economic terms under which it will be available. Not all fuels are covered in this study. Fuels covered include products produced from crude oil: LPG (also imported directly), naphtha, distillate, low-sulfur fuel oil at several levels of sulfur content, and gasified high-sulfur residual fuel oil. Other clean fuels covered by the study include low- and medium-Btu gas and methanol produced from coal and from solid wastes, including agricultural and municipal wastes. Hydrogen is assumed not to be a fuel technologically usable under reasonable economic conditions, i.e., reasonably commercial, in any significant quantities over the time period covered by this study. Excluded from this study on the basis that the State already has sufficient data are LNG, high-Btu gas produced from coal or other feedstocks, and products produced from potential coal-liquefaction processes.

56783 Energy projections: oil, natural gas, and coal in the USSR and Eastern Europe. Hoffman, G.W. (Univ. of Texas, Austin). *Energy Policy;* 7: No. 3, 232-241(Sep 1979).

There have been many projections of energy supply and demand for the USSR and Eastern Europe, but little agreement on future trends. In this article, Dr. Hoffman assembles a variety of published forecasts of Soviet and Eastern European energy production, consumption, imports, and exports. This allows comparison of the available data sources and illustrates the range of estimates for gas, coal, oil, and nuclear power. The author also outlines the Soviet and Eastern European energy resource base and provides an extensive bibliography with 80 references.

56784 Energy crisis: overview and analysis. Athens, GA; University of Georgia (1977). 39p. (NP—23997).

In the fall of 1976, Mr. Dean Rusk, Samuel H. Sibley Professor of International Law at the University of Georgia, spoke at the joint Tech-Georgia Development Fund dinner. His vision of these two great Georgia institutions working together for a single cause suggested to him an approach to examining the energy crisis from a fresh, honest, and in-depth point of view. As a consequence, he proposed to President Davison that he and President Pettit pull together the best minds in every field from both institutions for a standing colloquium on energy to be held every six weeks, alternating the meeting sites between the campuses; this caught the imagination of both presidents, and plans went forward for organizing the colloquia. Collected in this publication are the papers presented at the first two colloquia on energy, namely: Alternate Energy Sources, by Thomas E. Stelson; An Inventory of Domestic Energy Resources with a Focus on the Fossil Fuels, by Serge Gonzales; Potentialities of Biomass as Sources of Energy, by Claud L. Brown; The Future of Nuclear Energy, by L.E. Weaver and R.A. Karam; and The Carter Energy Program, by J. William Futrell.

COAL

56785 (CONF-7810176—, pp 311-333) **World War II German synfuels program. Luncheon address.** Irgolic, K.J. (Texas A & M Univ., College Station). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Coal-liquefaction development in Germany from 1931, when Friedrich Bergius won the Nobel Prize for his work on the conversion of coal to liquid products, through WW II is described. An additional technique, the Fischer-Tropsch Synthesis, provided Germany with the necessary tools for achieving self-sufficiency in petroleum fuels. This became a major national goal, the scientific community joining hands with private industry and government to perfect the coal-conversion process. More than 22 synthetic fuel plants were producing 90% of Germany's aviation gasoline and 68% of its regular military and civilian fuel by the end of World War II. The plants were later dismantled or converted to ammonia production or petroleum processing. Activities of the Technical Oil Mission, which first entered Germany in February 1975, and similar investigative groups in ferreting out and publishing technical information is described. Also, the present program at Texas A and M (German Document Retrieval Project) for extracting, translating, and making available the better cool-liquefaction information from the old German work is discussed.

PETROLEUM

REFER ALSO TO CITATION(S) 56030

56786 (CONF-7810176—, pp 335-353) **Fire-safe diesel-fuel emulsions. Special presentation.** LePera, M.E. (Army Mobility Equipment R & D Command, Fort Belvoir, VA); Quillian, R.D. Jr.; Fodor, G.E.; Ecklund, E.E.; Weatherford, W.D. Jr. Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Five brief individual reports on fire-safe fuel (FSF) are included in the conference because earlier exaggerations by the media misled the public on the status of the Army's FSF development program. The hybrid self-extinguishing diesel fuel is now in the prototype stage of laboratory testing and assessment of fuel characteristics and engine modifications. The reports cover the Army's goals, fuel preparation and emulsion composition, and the implications for fire-safe fuels. They conclude with an open discussion about the potential for FSF and the projection that the fuel will be in the field by the mid-1980's.

NATURAL GAS

REFER ALSO TO CITATION(S) 56041, 56048

56787 (INKA-Conf—78-209-001) **Gas: a promising form of energy.** Maier, F.H. (Bayerische Ferngas G.m.b.H. - Bayerngas, Muenchen (Germany, F.R.)). 1978. 35p. (In German). (CONF-7809165—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 33. general meeting of the DELIWA-VEREIN e.v.; Augsburg, F.R. Germany (14 Sep 1978).

The following targets should be focused for the whole energy economics sector in the Federal Republic of Germany: the scattering of energy carriers and the diversification of the sources of supply, the opening up of a technical and economic possibilities of covering energy demand, the economical energy consumption and the utilization of all new technologies. The securing of energy supply in the long term is seen above all with regard to gas industry. In the end, a development plan on energy demand in Bavaria is made and the tasks of Bayerische Ferngas, G.m.b.H., BAYERNGAS, are described.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 56794, 56795

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 56780, 56781, 56782, 56785

56788 (CONF-7810176—) **Composition of transportation synfuels: R & D needs, strategies and actions.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Jun 1979. 372p. Dep. NTIS, PC A16/MF A01.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

This conference was hosted by Southwest Research Institute with the support of the United States Department of Energy. Persons in attendance were key members of the technical community who are actively involved in the development and utilization of nonpetroleum domestic resources for transportation fuels. Generally, attendees represented the federal, military, industrial, and academic sectors of the domestic effort to develop synthetic fuels. The basic conference objective was to gather and organize facts and opinions which would enable the Department of Energy's Transportation Energy Conservation Division to (a) identify adjustments that may be needed in their Alternative Fuels Utilization Program strategies, and (b) define specific R & D project work on finished formulations of synthetic fuels which may have economic or environmental impact upon the domestic transportation scene. Twenty-two individual abstracts were prepared, all of which will appear in both Energy Research Abstracts (ERA) and Energy Abstracts for Policy Analysis (EAPA).

56789 (CONF-7810176—, pp 25-44) **Alternative Fuels Utilization Program.** Fleming, R.D. (Department of Energy, Washington, DC). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

A DOE program to extend and replace petroleum with synthetic fuels from oil shale and coal could prevent serious disruptions when domestic petroleum reserves are depleted. DOE's plan is to lower the uncertainty costs of using alternative fuels. Five fuel categories under consideration are, in order of priority: new hydrocarbons, alcohols, synfuels, advanced fuels, and emergency fuels. Only new hydrocarbons and synfuels are addressed in detail here, the programmatic aspects of the other three stated very briefly. The objectives related to these fuels and the strategies planned for attaining these objectives are described. The project work flow plan is based on a matrix progression from problem definition to large-scale adaptation. Four major factors - process technology assess-

ment, fuel properties and composition, engine-vehicle characterization, and systems studies of the socio-economic, environmental, and institutional factors - are considered in terms of resource-through-end-use.

56790 (CONF-7810176—, pp 49-53) **Forces at work affecting liquid synfuels development.** Hurn, R.W. (Department of Energy, Bartlesville, OK). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The atmosphere in which Federal fuel/engine technology programs for the transportation sector are proceeding is described as one in which the nature of vehicles and transportation modes will depend on which fuels receive the highest research and development priority, but also one in which the present effort separates those working on engine designs from those working on fuels. Because technological developments take place over a period of time, a choice between evolutionary and revolutionary change is possible. Changes in engine design and fuel mixtures in the 1980s will lead to higher-fuel-quality requirements. If diesel and turbocharged engines recieve more emphasis, for example, this will affect the form of synthetic fuel development. The stratefied-charge engine's success is less sure because of its complex fuel injection/ignition/ combustion sequence. Long-term developments could introduce feasible continuous combustion systems able to use interchangeable fuels. A trend toward dieselization will alter the refinery energy requirements. Engines that are adaptable to a variety of fuels and a simulanteous fuels development are recommended as the most logical program to pursue.

56791 (CONF-7810176—, pp 57-64) **Impact of synfuels on civil aviation.** Horeff, T.G. (Federal Aviation Administration, Washington, DC). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Fuel demands of 16.2 billion gallons of jet fuel/yr by 1988 are projected for civil aviation, which uses about four percent of US transportation energy. Conservation could reduce this amount by five billion gallons. Jet-fuel supplies could also be increased by switching from naptha-based fuel to kerojet. Studies of synthetic fuels indicate that shale oil is the most viable and that coal liquids, while technically feasible, would cost more to meet the current specifications for boiling range and aromatics content. The role of synthetic fuels will be affected by how much the specifications can be broadened because synthetic fuels introduce a number of engine, environmental, and fuel-stability problems. The goal is to have a broad-specification referee fuel available for both new and retrofitted engines by the 1990s. 7 references.

56792 (CONF-7810176—, pp 69-86) **Panel on defense mobility fuels: opening remarks.** Lukens, L.A. (Naval Materiel Command, Washington, DC). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The Department of Defense (DOD) uses about two percent of the national energy in peacetime and would triple its consumption during wartime, with most of its requirements for petroleum fuels. Because weapons systems continue to be designed to use petroleum-like fuels, acceptable alternatives will have to be fossil-energy derivatives in the near term. Emphasis will probably be placed on oil shale rather than coal liquefaction for economic and technological reasons. The conversion of syncrudes into refined petroleum products is not yet economically competitive, but the armed forces must first be persuaded that synfuels are suitable for military use before they will make a commitment. A comprehensive Defense Mobility Fuels Action Plan is outlined that would assess synthetic fuels for their suitability and would specify, on the basis of research, the necessary fuel specifications and guidelines.

56793 (CONF-7810176—, pp 99-111) **Properties and composition of jet fuels derived from alternate energy sources. Part I. Background and n-alkane content.** Hazlett, R.N. (Naval Research Lab., Washington, DC); Hall, J.M.; Solash, J. Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The critical properties (heat of combustion, freezing point, flash point, combustion properties, thermal oxidation stability, and gum formation) of jet fuel JP-5 are described and compared with fuels made from oil shale, tar sands, and coal, whose critical properties are heat of combustion, freezing point/flash point, combustion properties, stability, and n-alkane content. Although synthetic jet fuels can be made, refining processes and processing conditions must be modified. A better understanding of the critical properties will help to develop these modifications and reduce the costs of new fuels. 25 references.

56794 (CONF-7810176—, pp 112-125) **Thermal oxidative stability of synthetic jet fuels.** Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

A Naval Air Propulsion Center program to establish that jet fuel JP-5 derived from non-petroleum sources is physically and chemically suitable for aircraft propulsion systems focuses, in this report, on the effects of nitrogen on thermal oxidation stability and storage stability. The study will lead to specifications for nitrogen control in JP-5. Research activities are described and the results are summarized. Pyridene-type compounds were found to be relatively innocuous, while pyridene compounds containing primary amine functional groups and pyrroles were both found to have deleterious results. Some correlation was found in the storage stability tests of oil shale fuels with low concentrations of nitrogen, but peroxidation could be controlled by an inhibitor.

56795 (CONF-7810176—, pp 127-145) **USAF alternative-fuel program.** Lander, H.R. Jr. (US Air Force Aero Propulsion Lab., Wright Patterson AFB, OH). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Increases in jet-fuel costs have led the Air Force to explore other domestic sources of liquid hydrocarbons, especially shale oil, which is chemically suited and the closest to a commercial stage. The Air Force participation in shale oil research is intended to specify future turbine fuel requirements in a way that will maximize availability and minimize costs. A cleanup of the fuel by clay absorption and additives derived JP-4, a viable aviation fuel. Further research was conducted to see how much fuel properties can be varied without adverse effects. This will establish the specifications necessary for a smooth fuel transition. The Air Force study concludes that a domestic synthetic fuel industry must be developed even if US petroleum reserves increase substantially. 4 references.

56796 (CONF-7810176—, pp 149-154) **Synfuels R and D status and projections: introductory remarks.** Carey, A.W. Jr. (Cummins Engine Co., Columbus, IN). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

An engine industry representative outlines three concerns about industrial synfuels: (1) will petroleum substitutes be capable of filling the supply gap as the petroleum shortage materializes; (2) will present fuel specifications be maintained as the percentage of syncrude increases; (3) will this optimize energy resources and, if not, will it be economical to produce fuels that are different from today's fuels. The fuel industry needs to define synfuel more precisely in order to communicate better with engine builders. It also needs to provide candidate fuels as soon as possible so the engine manufacturers can determine which modifications are needed.

56797 (CONF-7810176—, pp 155-161) **Broadcut-fueled engines using non-hydrocracked shale or coal-pyrolysis liquids as fuels: an alternative engine/fuel strategy.** Rightmire, R.A. (Standard Oil Co., Cleveland, OH). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

An alternative to hydrocracking crude shale oil and coal to refinable liquids of compositions nearly identical to gasoline and diesel fuel is needed. One approach is to develop engines that work on hydrocarbon liquids derived by simple processing steps from shale oil or coal-pyrolysis liquids. This approach presents several engine-combustion problems and would require new engine designs, such as the direct-injected stratified-charge engine.

56798 (CONF-7810176—, pp 187-193) **Composition of transportation synfuels.** Jackson, R.G. (Continental Oil Co., Ponca City, OK). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The author considers oil shale or coal gasification to be the only viable near-term source of transportation synfuels and outlines an approach for building on present technology. Those processes which can produce liquid fuels with a minimum of modification and loss of energy should be emphasized. Government participation should be to establish a goal (such as one million barrels per day of synfuel production by 1990) and create a limited market in which all unconventional sources can compete freely without mandated quotas. Research priority should go to automotive fuels to keep pace with engine research.

56799 (CONF-7810176—, pp 197-210) **R & D project brainstorming.** Timbario, T.J. (Mueller Associates, Inc., Baltimore, MD). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Team action and creative engineering are suggested as the basis for brainstorming ideas and projects for synthetic and alternative fuels and for transportation energy conservation. Twenty-six speakers participate in the open discussion and compile an idea list which includes: (1) counterproposals for using professional societies and public figures to bring the synfuels message to public attention; (2) the advisability of introducing a new fuel through utilities rather than the transportation sector; (3) the likelihood that many of the economic uncertainties will disappear while a pure synthetic transportation fuel is being developed; (4) the question of how much we are willing to pay for energy independence; and (5) the need for a government-subsidized synfuels plant and regulated sales to refineries.

56800 (CONF-7810176—, pp 215-217) **Remarks for the opening of the university synfuels R and D panel.** Lestz, S.S. (Pennsylvania State Univ., University Park). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The panel moderator discusses briefly some of the less-obvious reasons for holding a conference on the research and development of synfuels for transportation and the importance of developing a liquid fuel similar to present fuels if it is to be generally acceptable. Conferences can provide the opportunity to develop an awareness of critical needs, set priorities, and make a commitment that will ensure future fuel supplies. Synthetic fuels that can satisfy present logistical and hardware needs depend on continued basic research into the physical characteristics of these fuels so that modifications can be made to combustion and fuel management systems and make them compatible with the fuels. Multidisciplinary teams at universities can provide this research.

56801 (CONF-7810176—, pp 223-251) **Transportation fuels: 1978 crude oil scene.** Uyehara, O.A. (Univ. of Wisconsin, Madison). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Depletion dates of US and world reserves of natural crude oil are estimated and the case presented for starting immediately to build a syncrude plant that will produce four million barrels a day from coal. If the product is mixed with regular crude oil, it would be able to meet more transportation fuel requirements and reduce petroleum import levels sooner. The chemical properties of synfuels and the estimated development costs are summarized. The answer to several questions will, when available, indicate the feasibility of refining transportation fuels from synthetic crude oil.

56802 (CONF-7810176—, pp 253-268) **Transportation fuels: critical research problems.** Mellor, A.M. (Purdue Univ., West Lafayette, IN). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Several research areas are summarized: (1) Pulsed-spray ignition by fuel injection can counteract the tendency for misfiring when lean fuel mixtures are used, although the lean limit can be affected by a number of fuel properties which need to be determined. (2) Combustion efficiency is related to fuel type and decreases with the use of heavier, more viscous and less-volatile fuels. This has implications for the Army's decision to develop a gas-turbine multi-fuel tank engine. (3) Soot formation and deposits caused by gas-turbine combustor and intensified by the use of heavy fuels can affect film cooling, damage turbine blades, clog passages, and produce a visible exhaust plume of tactical significance to military equipment. The fuel parameters for gas turbine combustors are examined and fuel viscosity and volatility are concluded to be the major performance determinants.

56803 (CONF-7810176—, pp 269-282) **Transportation fuels research and technical education.** Johnson, R.T. (Univ. of Missouri, Rolla). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

The advantages and disadvantages of performing engineering research in universities are outlined and applied to the alternative fuels and propulsion system programs at the University of Missouri-Rolla (UMR). University research programs suffer from having part-time faculty and student participants, student inexperience, and from financial and educational constraints. These same programs have the advantage, however, of individual freedom for the researchers, an emphasis on information instead of product, objectivity, public acceptance, and low cost. UMR's program of vehicle fuels and engine research, assuming that spark-ignition and diesel engines will continue to dominate the transportation sector, focuses on engine efficiency and modification, fuel characterisitic identification, and fuel blending with other fuels and additives to achieve good performance with fuel economy and pollution control. The university is in a unique position to undertake high-risk research on synfuels and, at the same time, develop trained technical personnel.

56804 (CONF-7810176—, pp 283-310) **Composition and performance of PARAHO synfuels.** Robinson, E.T. (Standard Oil Co., Warrensville, OH); Kunchal, S.K. Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Pilot plant studies on shale oil-derived fuels are reported by the Standard Oil Company of Ohio. A series of charts and graphs summarizes the results of PARAHO shale oil analyses, shale oil refining process, hydrotreating, and the composition and stability fo shale-derived fuels. The conclusions drawn from this information are that: (1) a settling pre-treatment, guard-bed to protect the catalyst, hydrotreating, and acid/clay treating are all required; (2) hydrotreated shale oil can produce yields of six percent gasoline, 24% jet fuel, 35% diesel fuel marine, and 35% heavy fuel oil; and (3) it is possible to produce specification military fuels.

56805 (CONF-7810176—, pp 355-377) **Means to stimulate R & D actions: workshop.** Parker, A.J. Jr. (Mueller Associates, Inc., Baltimore, MD). Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Positive suggestions are elicited for research and development on synthetic transportation fuels from coal and oil shale. The moderator notes that the fuel makers were having more input into the conference than the fuel users and that this imbalance could lead to frustrations unless the fuel users' silence reflects the lack of a problem. He sees a general consensus among participants that research is needed on fuel specifications, combustion characteristics, scale-up problems, and refinery organization. He questions the need for a systems approach and whether economics should not be a consideration in oil-shale development. Twenty speakers participated in the ensuing discussion of these and other issues. Concern was expressed that technical experts are not communicating effectively with the public.

56806 (CONF-7810176—, pp 379-394) **Direction for synfuels R & D: final summary panel.** Fleming, R.D. (Department of Energy, Washington, DC); Brinkman, D.W.; Taylor, W.R.; Paraskos, J.A.; Ryan, D.; Colucci, J.M.; Baker, R.E.; Pefley, R.K. Jun 1979.

From Conference on composition of transportation synfuels: R and D needs, strategies and actions; San Antonio, TX, USA (11 Oct 1978).

Each of the major sectors participating in the conference on transportation synfuels was represented on the final panel to make relevant comments. Some noted that the major obstacles to a commercial synfuel industry appear to be non-technical, although industry can help to reduce some of those obstacles by providing technical feasibility. Their attitude was one of Lets get on with it. Other speakers stressed the need for more basic research on fuel characteristics and refining, the use of a systems approach, and greater financial support from the government. Several speakers contributed their personal concerns during the open discussion.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 56784

56807 (FGMSD—78-7) **Securities and Exchange Commission's regulation of public utility holding companies: an evaluation of Commission comments on a critical report.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 4 Jan 1978. 47p. General Accounting Office, Gaithersburg, MD.

Report to the Congress of the United States by the Comptroller General.

A report entitled: The Force of the Public Utility Holding Company Act Has Been Greatly Reduced By Changes in the Securities and Exchange Commission's Enforcement Policies, was issued June 20, 1977 by the GAO. The report raised questions concerning the narrowness of the Commission's administration of a statute which the Congress had intended to be wide-ranging and pervasive. On June 30, 1977, the Securities and Exchange Commission issued comments rejecting all of the reports recommendations. This report summarizes the findings of GAO's earlier report. GAO's evaluation of the Commission comments is presented in Appendix I and the Commission's comments are presented in Appendix II.

56808 (NP—23961) **Summary of the utility common forecasting methodology II: demand forecast submissions. Staff report.** Joyner,

D.; Husted, A. (California Energy Commission, Sacramento (USA)). Jun 1978. 42p. Dep. NTIS, PC A03/MF A01.

This report summarizes the electricity sales and peak demand forecasts submitted by five major California utilities pursuant to the regulations governing the common forecasting methodology (CFM II). The utilities' CFM I submissions and the Energy Commission's adopted forecasts are presented for comparison. Six tables provide an overview of the sales and peak forecasts contained in the utility CFM II demand forecast submittals. In Table 1, the utilities combined project electricity sales to increase at an average rate of 4.2% annually through 1998 as compared to a 3.8% increase over the past ten years. The peak demand forecasts in Table 2 are projected to grow at slower rates than total electric sales, with growth averaging 3.6% annually. The disaggregation by sector (Table 3) indicates that commercial electric sales are projected to grow fastest with an average rate of 4.9% annually over the twenty year period. The industrial sector follows second (4.3%) with the residential (3.7%) and other (2.3%) sectors experiencing the lowest growth rates. Considerable variation exists in the projections of real prices of electricity among utilities (Table 4). Except for Southern California Edison, the utilities are projecting a decline in real electricity prices over the next twenty years. Table 5 portrays the economic growth assumptions that are used to drive the utilities' electricity forecasting models. In Table 6, the economic projections made by recognized forecasters are displayed to serve as benchmarks.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 56743, 56783, 56817

56809 Preliminary report on the Pacific Gas and Electric Company's Notice of Intention to seek certification for a coal-fired power plant, Fossil 1 and 2. Sacramento, CA; California Energy Resources Conservation and Development Commission (1978). 154p. (NP—23914). California Energy Resources Conservation and Development Commission, 1111 Howe Ave., Sacramento, CA.

A preliminary report is presented regarding Pacific Gas and Electric Company's Notice of Intention (NOI) for Certification for construction and operation of a 2-unit 1600-MW coal-fired facility in Northern California. In the NOI, the applicant submits information to demonstrate the need for the facility, its comparability with applicable governmental standards, and the reasonableness of its health and safety, environmental, and financial characteristics. The California Energy Commission identifies one or more of the four alternative siting proposals as acceptable. (MCW)

56810 Preliminary report on the Southern California Edison Company's Notice of Intention to seek certification for a combined cycle generating station. Sacramento, CA; California Energy Commission (1978). 261p. (NP—23915). California Energy Commission, 1111 Howe Ave., Sacramento, CA.

A preliminary report is presented regarding Southern California Edison Company's Notice of Intention (NOI) for Certification for construction and operation of a 1290-MW combined-cycle net generating capacity plant consisting of 3 modules. In the NOI, the applicant submits information to demonstrate the need for the facility, its comparability with applicable governmental standards, and the reasonableness of its health and safety, environmental, and financial characteristics. The California Energy Commission identifies one or more of the four alternative siting proposals as acceptable. (MCW)

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 56777, 56829, 56840, 56844, 56859

56811 (ORAU/IEA—79-12(R)) **Total costs of energy services.** Reister, D.B.; Devine, W.D. Jr. (Oak Ridge Associated Universities, Inc., TN (USA)). Jun 1979. Contract EY-76-C-05-0033. 111p. Dep. NTIS, PC A06/MF A01.

An energy service may be defined as a measure of the service actually provided to ultimate consumers by their own use of energy, quantified, for example, using units of work or of heat at various temperatures. This paper presents estimates of total costs of 15 energy services for the year 1972. These costs include the cost of producing and distributing commercial forms of energy, the cost of the equipment that utilizes this energy in providing services, and the cost of operating and maintaining the end-use equipment. The overall cost of energy service in 1972 is estimated to be nearly $400 billion, a figure equal in magnitude to about one-third of the 1972 gross national product. Categories of energy services are identified in which major technological changes in the manner of providing the service might make the greatest difference in the overall cost of energy service.

56812 Energy demand and conservation in US residential and commercial buildings: impact of the US National Energy Plan. Hirst, E. (Oak Ridge National Lab., TN); Jackson, J. *Energy Policy;* 7: No. 3, 208-214(Sep 1979).

This paper evaluates the impact of the US National Energy Plan on energy demand in US commercial and residential buildings. Following a brief historical review of energy-use patterns in US buildings, estimates are presented of how the National Energy Plan would affect the sector in terms of fuel expenditures and investment in energy using equipment and structures. The analysis is based on economic-engineering models of energy demand which are currently being used by the US Department of Energy to evaluate conservation programs. The demand models incorporate behavioral as well as technological determinants and are sufficiently disaggregated to allow consideration of individual components of the National Energy Plan.

UNCONVENTIONAL SOURCES AND POWER GENERATION

56813 (NP—23911(Vol.2)) **Energy self-sufficiency for the county of Maui. Volume II. Developmental plan.** Masuda, R.; Seki, A.; Takahashi, P.K.; Yuen, P.C. (Hawaii Univ., Honolulu (USA). Hawaii Natural Energy Inst.). Jun 1978. 137p. NTIS, PC A07/MF A01.

Alternative routes by which energy self-sufficiency can be reached in Maui County are outlined in Volume II. The analysis considers the economic, environmental, sociological, political, and technological factors in designing a flexible framework which can be used by the people of Maui County to determine their energy destiny. Following a summary of Volume I, indigenous energy alternatives (biomass, wind power, solar energy, geothermal energy, ocean thermal energy conversion, hydroelectric energy) are summarized. The present status of new technologies and an energy scenario for the county are discussed. An energy self-sufficiency analysis focuses on electrical and net energy self-sufficiency. The data for 1976 bring together the latest information available. In addition to 70% petroleum, sugar cane and hydroelectricity provide all the energy used in the county.

56814 (NP—23911(Vol.3)) **Energy self-sufficiency for the county of Maui. Volume III. Energy Plan.** Masuda, R.; Seki, A.; Takahashi, P.K.; Yuen, P.C. (Hawaii Univ., Honolulu (USA). Hawaii Natural Energy Inst.). Jan 1979. 112p. NTIS, PC A06/MF A01.

Volume I presented the current energy picture of Maui county, while Volume II projected a number of tentative energy scenarios. This volume, Vol. III, comprehensively analyzes the future of energy in the county and selects the most-probable scenario. The scenario assumes Maui County's present high growth rate will eventually drop to a moderate and then a low rate. The county can reach energy self-sufficiency in 1995 at a cost of $710.9 million. The major natural energy resouces are the indigenous ones: geothermal, biomass, wind, and solar. Conservation, of course, will play an important role. An energy plan is drawn up, which details the development program for the components - each natural energy resource, conservation, submarine electric cable, transportation, conservation, legislation, community awareness and interaction, and energy plan updating. 34 references.

SOLAR

REFER ALSO TO CITATION(S) 56204, 56206, 56207, 56208, 56211, 56212, 56239, 56240, 56246, 56249, 56255, 56261, 56262, 56280, 56306, 56764

56815 Southern Regional Solar Energy Center planning. Graves, G.B. (Southern Solar Energy Planning Project, Atlanta, GA). pp 11-22 of Application of solar energy: 1978. Wu, S.T.; Christensen, D.L.; Head, R.R. (eds.). Huntsville, AL; University of Alabama (1978).

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

In January, 1978, a solar technology planning grant was awarded to the Southern region. The Southern region consists of Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisisana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia, the District of Columbia, Puerto Rico, and the Virgin Islands. Planning activity is located in Atlanta, Georgia, under the supervision of a Solar Project Committee which consists of a gubernatorial appointee for each jurisdiction in the rgion. The Southern States Energy Board, an interstate compact agency which serves as the energy arm of the Southern Governors' Conference, supports the effort by handling contract administration. Key management personnel are G. Barry Graves and William E. Stoney who serve as Director and Deputy Director of the Planning Project. The objective of the Southern Regional Solar Energy Planning Project is to provide both an organizational structure and a work program that can be effective in developing and transferring solar technologies to use in concert with

overall energy policies. The program activities and planning approach are described. (WHK)

GEOTHERMAL

REFER ALSO TO CITATION(S) 56324, 56337, 56339, 56340, 56342, 56343, 56344, 56345, 56360, 56361, 56362

OTHER

REFER ALSO TO CITATION(S) 56194, 56743, 56782, 56784

56816 (CONF-7905105—2) **Urban energy opportunities.** Kron, N.F. Jr. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From Conference on using land to save energy; Chicago, IL, USA (18 May 1979).

Comments on various renewable energy technologies to which urban areas may convert are made. Community- or city-scale use of solar and wind power cannot economically or practically compete with oil presently. Surface water and ground water both contain quantities of heat that can be extracted by using a heat pump or piping systems. The technology for extracting the heat is available for use on a neighborhood or industrial park level. Solid and liquid wastes and biomass hold promise for producing urban energy. One ignored energy source is better utilization of the fuel used for electricity production. The overall fuel efficiency of the plants can be improved if the waste heat is delivered to customers for use in heating and cooling their homes and businesses. The technology for transferring the heat by hot water or steam exists. The author then cites two examples of community scale use of energy systems. An analysis at Soldier's Grove, Wisconsin, revealed that the town could burn waste wood from nearby lumber mills in a central boiler to supply heating, cooling, and domestic hot water. The systems, only using oil for ignition, should pay back in about 2 years. An Argonne study showed that large cities' (Philadelphia) heating loads could be supplied profitably through district heating using power plant waste heat, at a cost of over $2 billion, but at a payback period of less than 9 years (1978 study). Other problems facing urban areas to exploit other energy sources are briefly noted. (MCW)

56817 (DSD—103-1) **Direct and indirect costs of transporting wood chips to supply a wood-fired power plant.** Adler, T.J.; Blakey, M.; Meyer, T. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Apr 1978. Contract EG-77-C-02-4487. 77p. Dep. NTIS, PC A05/MF A01.

The type of transportation system employed by a wood-fired power plant (WFPP) will have a major impact on the success or failure of that operation. Procedures employed in transporting the wood influence the cost and the community's acceptance of the plant. Several alternative designs of a transportation system for a hypothetical 50-MW WFPP in Vermont are analyzed. Two means - truck and rail - of moving the fuel, wood chips, from the harvest site to the WFPP are investigated. Either transportation system will require special techniques for loading and unloading wood chips. For trucking, the system would include unloading equipment at the plant. For rail transport, truck-train transfer equipment is needed, along with machinery to unload the railcars at the plant. The direct cost of both systems is summarized with their possible variations, as accurately as possible, and compare the general cost ranges of the two. Although cost factors will vary greatly depending on the location and particular design specifications of the WFPP, it is concluded that the 35-truck fleet is probably the least-cost system in terms of capital costs. The analysis concludes that the specific WFPP site has a strong influence on the costs - direct and indirect - of the various possible transportation systems.

56818 **Energies nouvelles/nouvelles possibilites. Programmes pour le developpement des energies renouvelables et les economies d'energie. (New energy/new opportunities. Programs to develop renewable energy and conservation).** Ottawa, Ontario; Energy, Mines and Resources (1979). 94p. (EI—79-1). Energy, Mines and Resources, Energy Communications Div., 580 Booth Street, Ottawa, Ontario.

Renewable Energy and Conservation will play a role in meeting Canada's future energy demands whether it be solar heating, wind power, biomass energy from forests, or geothermal power. The government's goal is the commercialization of promising technologies, and various departments are now developing programs related to this goal. Information is given here on government programs that could apply in the research or development of products and services related to renewable energy. Many of these programs are new and are specifically designed for renewable energy and conservation, while others are only supportive but could apply to the development of these technologies. Most programs are designed for small- to medium-sized enterprises. This publication presents an overview of what is available.

56819 **Energy and economic assessment of anaeroic digesters and biofuels for rural waste management.** Abeles, T.P.; Freedman, D.F.; DeBaere, L.A.; Ellsworth, D.A. Cincinnati, OH; Environmental Protection Agency (1978). 168p. (NP—23969). Environmental Protection Agency, Municipal Research Lab., Cincinnati, OH.

A technological and socioeconomic assessment of anaerobic digester feasibility for small- to mid-size livestock operations was undertaken. Materials handling presented the greatest obstacle to satisfactory operation of the full-scale systems. Conversion of the biogas to electricity via standard engine-generator sets is capital- and maintenance-intensive. Electrical conversion requires engine-generator sets that can add 30% to the cost of the system, and that have conversion efficiencies of only 10 to 25%. The system becomes more economical if the biogas can be used on site for direct thermal loads, suggesting that the economic feasibility of anaeroic digesters is site specific and should be closely integrated with the total farming operation. If excess engine heat can be recovered from electrical-conversion equipment, and if provisins can be made on the farm to level electrical loads and conserve energy, then the economics are enhanced. Analysis was performed for farms with 100 animal units. Laboratory studies using a 2:1 mixture of dairy manure to Municipal Solid Waste showed that the biogas production per pound of volatile solids added is nearly the same as for straight manure. Addition of the organic portion of MSW to small farm digesters could make marginal systems economically attractive. Preliminary refeed studies indicated that the digested manure may not have the same nutritional value as raw manure, and that the cost of dehydrating the effluennt for refeed to the same animals could be cost prohibitive for the small to mid-size farming operation.

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 57084

56820 (DOE/NASA/2674—79/7) **NASA Lewis closed-cycle magnetohydrodynamics plant analysis.** Penko, P.F. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EF-77-A-01-2674. 14p. (NASA-TM—79249). Dep. NTIS, PC A02/MF A01.

A brief review of preliminary analyses of coal fired closed cycle MHD power plants that was conducted at the NASA Lewis Research Center in support of DOE funded closed cycle MHD contracted studies is given. The emphasis is on comparison of performance for three power plants with differing combustion systems. The same MHD/steam combined cycle was used for each plant. The combustion systems considered were: (1) a direct coal-fired combustor; (2) a coal gasifier with in-bed desulfurization; and (3) a coal gasifier requiring external fuel gas cleanup. Power plant efficiencies (auxiliary power excluded) were 44.5, 43, and 41 percent for the three plants, respectively.

56821 (JPRS—73388, pp 19-22) **Power industry application of MHD technology.** Sheyndlin, A. 7 May 1979. Translated from Izvestiya; 3(30 Mar 1979). NTIS.

In Translations on USSR science and technology: Physical Sciences and Technology, No. 67.

The status of MHD generator research in the USSR is discussed, and the cooperative research on MHD generators by the USA and USSR is outlined. Plans for USSR MHD power plants are outlined. (WHK)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 56820

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 57007

56822 (ANL/MHD—79-9) **Evaluation of ceramic refractories for corrosion behavior by molten slag-seed mixture of a coal-fired open-cycle MHD system.** Singh, R.N.; Kennedy, C.R.; Fousek, R.J.; Jones, D.J.; Kreis, S.W.; Mailhiot, R.E.; Poeppel, R.B. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 42p. Dep. NTIS, PC A03/MF A01.

In an investigation of the possible use of a refractory material on the water walls of a radiant boiler in a coal-fired open-cycle MHD plant, the corrosion of a wide variety of commercial refractories was studied under reducing conditions at ~ 1500°C in a coal-ash slag/potassium seed mixture. For several refractories, the results

appear promising. Compared with earlier results obtained with slag only at ~ 1500°C, the presence of ~ 10 mass percent K_2O seed in the Montana Rosebud slag did not result in increased corrosion, and may actually have improved the corrosion resistance of many of the refractories that were tested. Of the fused-cast materials, the chrome-spinel refractory exhibited superior corrosion resistance. The magnesia-chrome refractories have shown more resistance to corrosion than the other sintered materials that were tested. A phosphate-bonded chrome-ore ramming mix performed better than the other ramming mixes, but not as well as any of the sintered or fused-cast bricks.

56823 (CONF-790815—29) **Final design of a superconducting MHD magnet for the Coal-Fired Flow Facility at the University of Tennessee Space Institute.** Wang, S.T.; Turner, L.R.; Genens, L.; Pelczarski, W.; Hoffman, J.; Gonczy, J.; Ludwig, H.; Niemann, R.C.; Mataya, K.; Kraft, E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 19p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

The superconducting magnet system (SCMS) consisting of the superconducting magnet, magnet cryostat, a helium refrigerator/liquefier facility, a helium gas-handling system, apparatus for cryogenic transfer and storage, a magnet power supply, a integrated instrumentation and control system including a computer for magnet operation, data acquisition, system status and diagnosis, and magnet protection is described. The complete system will be tested at Argonne and installed at the Coal-Fired Flow Facility (CFFF) at the University of Tennessee Space Institute (UTSI) in 1981. The coil configuration is the US SCMS type circular saddle. The coil wil be assembled on the magnet tube with spiral banding. The bore tube will be about 6.3 cm thick (in the thickest section) and the banding will be strong enough for coil assembly but too weak to transmit the 30,180 kgf/cm maximum burst force to the bore tube. Fifteen ring girders will be used as the superstructure to contain the force. The decentering force of about 0.2177×10^6 kgf will be taken up by end flanges and bore tubes.

DUCT ENGINEERING AND FLUID DYNAMICS

56824 **Experimental and analytical investigation of an MHD channel window frame.** Srinivasan, M.G. (Argonne National Lab., IL (USA)); Krajcinovic, D. (Illinois Univ., Chicago (USA)). pp L8/2 1-8 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A common design of magnetohydrodynamic (MHD) generator channel emphasizes a series of mutually connected window frames providing the support for electrodes and containing the jet of ionized gases. Structurally, a window frame is a rectangular frame with a cross section in the form of a quadrilateral weakened by one or more holes forming the cooling system. Window frames are joined together to make a beam with a box cross section by means of shear pins. A typical window frame is subjected to a rather severe environment characterized by large pressure and high temperatures. The main sources of stresses and strains would include static and dynamic gas pressures and thermal fields characterized by large gradients across the thickness of frame members. The authors consider only the stresses associated with thermal fields. The actual problem is still a very complex one involving analysis of the heat conduction through the electrode-frame system heated by the gas and cooled by the coolant fluid and determination of stresses (elastic and plastic) in a frame with an irregular cross section. In order to obtain a reasonable qualitative and quantitative insight into the phenomenon, three distinctly different approaches have been used: a large elasto-plastic finite element program was used to determine the stresses in the actual frame, an experiment was performed to establish the stress concentrations around holes needed for the passage of coolant, and a two-bar model was used in order to assess the time-dependent behavior of the structure for various loading conditions.

FUEL CELLS

DESIGN AND DEVELOPMENT

56825 (CONF-790803—53) **Molten carbonate fuel cell systems development program.** Borys, S.S.; Ackerman, J.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

The objective of the US Department of Energy Molten Carbonate Fuel Cell (MCFC) Systems Development Program is to implement the earliest feasible commercial use of MCFC power plants operating on coal; implementation will provide benefits in cost of electricity, environmental quality, and resource conversation. Molten carbonate fuel cells operating at high temperature (~ 925 K) yield rapid kinetics, fuel flexibility, and high grade waste heat. Emissions of sulfur oxides, nitrogen oxides, and particulates from a MCFC power plant with an integrated coal gasifier will be well below any known competitive technology. Primary areas of cell development are scaleup, lifetime and cycling capabilities. Key milestones for the development of MCFC power plants are (1) operation of a prototype fuel cell assembly (stack) on simulated gas by late 1982, (2) operation of a prototype stack on coal gasifier product gas by late 1983, (3) operation of an integrated multi-MW test facility by mid-1985. Operation of a baseload power plant of several hundred megawatts can be achieved by 1990.

PERFORMANCE AND TESTING

56826 (LMSC/D—672691) **Role of microcomputers in secondary battery development and testing.** Hollandsworth, R.P.; Adams, G.B. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). 1979. Contract EM-78-C-01-5153. 4p. (CONF-791017—8). Dep. NTIS, PC A02/MF A01.

From 7. international conference on chemical vapor deposition; Los Angeles, CA, USA (14 Oct 1979).

The development process and application of a microcomputer system for secondary battery testing is described, with specific application to the development of the zinc-ferricyanide hybrid redox battery. System development begins with the layout of the logic processes conducted during the battery cycle sequence. In the development of a microcomputer system one should be aware of certain electronic traps, software bugs, and unanticipated hidden costs. System cost trade-offs occur when selecting the A/D converter. The decision of whether to use 8- or 12-bit resolution in the A/D converter is a serious one. The macroprocessor language Tiny Basic was selected. The system developed is capable of controlling the charge and discharge cycles of 6 or more secondary batteries based upon various operator-determined cell parameters, and computing at the end of each cycle the voltaic, coulombic, and energy efficiencies for each cell independently. These efficiencies and the cell parameters are then logged for later data manipulation and graphic representation. 2 figures. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

56827 **Electrochemical cell for rebalancing redox flow system.** Thaller, L.H. (to National Aeronautics and Space Administration). US Patent 4,159,366. 26 Jun 1979. Filed date 9 Jun 1978. 6p.

There is disclosed an electrically rechargeable REDOX cell or battery system including one or more rebalancing cells. Each rebalancing cell is divided into two chambers by an ion permeable membrane. The first chamber is fed with gaseous hydrogen and a cathode fluid which is circulated through the cathode chamber of the REDOX cell is also passed through the second chamber of the rebalancing cell. Electrochemical reactions take place on the surface of inert electrodes in the first and second chambers to rebalance the electrochemical capacity of the anode and cathode fluids of the REDOX system.

APPLICATIONS

REFER ALSO TO CITATION(S) 56219

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

56828 (ORNL—5485, pp 95-105) **Molten salt systems.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Topics in the molten carbonate fuel cell program include electrolysis and relaxation in Li_2CO_3-K_2CO_3, NiO cathodes in Li_2CO_3-K_2CO_3, and concentration cells with transference in Li_2CO_3-K_2CO_3. Transport and thermodynamic studies include electrochemical measurements on model systems simulating molten salt batteries, simulation of linear sweep voltammetry with composition dependent transport coefficients, and steady-state solutions of the migration diffusion equations for molten salt batteries and fuel cells. (WHK)

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

BUILDINGS

56829 (ORNL/EIS—150) **Buildings energy use data book: edition 2. Selected bibliography.** Ehrenshaft, A.R.; Barber, B.Y.; Carroll,

P.J.; Fielden, J.M.; Plemons, L.K.; Purnell, P.A.; Weaver, R.S. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 190p. Dep. NTIS, PC A09/MF A01.

This bibliography was prepared as a companion volume to the Buildings Energy Use Data Book, Edition 2 (ORNL-5552). References to statistical data in the residential/commercial sector are provided. Among the subjects covered are fuel availability, consumption, and prices; appliance inventories, shipments, and efficiencies;buildings inventory;population statistics; socioeconomic determinants; solar energy systems design, performance, and utilization; energy consumption in schools and hospitals; community systems; and government policies and legislation which affect energy consumption. All references are keyworded and arranged alphabetically by author or corporate author if individual authors are not cited in the document. Author, corporate author, sponsor, report number, keyword, and permuted title indexes are provided. The 644 documents cited in this volume represent the most relevant and/or current publications in residential and commercial energy use. A short bibliography of older documents may be found at the back of Edition 1 of the Buildings Energy Use Data Book, and a specialized bibliography relating to appliance inventories, efficiencies, and energy use in the residential sector was published as ORNL/EIS-141.

56830 (SIB-R—14-1979) **Heat pumps for the heating of buildings.** Kraft, H.; Fehrm, M.; Hill, A. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1979. 107p. (In Swedish). Dep. NTIS (US Sales Only), PC A06/MF A01.

The aim of this investigation was to experimentally study the components and systems of heat pumps, which could be used for the heating of villas. Seven different pumps have been studied. They represent three types of pumps, viz. air/water, soil/water and air/air. Furthermore, comparative studies of two defrosting methods have been performed, i.e., defrosting with hot gas and electric defrosting.

56831 (SIB-R—16-1979) **Group of houses at Esloev, Sweden, used for a pilot study of municipal engineering and energy conservation.** Broberg, P.; Johansson, K. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1979. 16p. (In Swedish). Dep. NTIS (US Sales Only), PC A08/MF A01.

An area at Esloev, Sweden, including 79 villas, a school, a day nursery and shops, was chosen for a pilot study of an experimental group of houses, for which more advanced systems for energy conservation have been introduced. The project is part of a necessary social effort to economize with all public resources. There is a need to decrease the demand of energy and try to decrease the costs for both investment and operation when building in the future.

56832 (SIB-R—20-1979) **Ground to water heat pump for a recreational area at Varberg, Sweden.** Ankargren, S.; Norin, F.; Straaaat, H. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1979. 37p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

A recreation area is going to be built at Varberg, Sweden. The geology at this place as well as the utilization time for the buildings are suitable for the use of the heat collected at the surface of the earth in a heat pump. In this project a heat absorber or collector in the soil has been constructed, the division of the heat pump into different units taking into consideration the reliability in operation has been studied as well as the principles for the internal heat supply using low temperature systems. The energy consumption per year for the area will be 1500 MWh. By the installation of the heat pump this figure will decrease to 500 MWh.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 56285, 56812

56833 (AED-CONF—78-268-008) **Extension of the Biberen heat pump system.** Winkler, J.P. (Soltron, Ingenieurbuero fuer Waerme- und Klimatechnik, Bern (Switzerland)). 1978. 31p. (In German). (CONF-7809111—6). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 2. Essen heat pump meeting: drives for heat pumps; Essen, F.R. Germany (6 Sep 1978).

Experience with a heat pump installed in 1977 in a two-family house is reported. The heat pump is driven by a diesel engine and uses the soil as a heat source. A combined heat and power system in which a diesel engine drives the heat pump and simultaneously generates power and is used as the heat source for a brine swimming pool is also described. All the technical and economic data for this system are presented. Finally, heat pump control equipment is discussed. All the systems described are in Switzerland.

56834 (DOE/TIC—10252) **Phase one/base data for the development of energy performance standards for new buildings.** (AIA Research Corp., Washington, DC (USA)). 12 Jan 1978. 111p. Dep. NTIS, PC A06/MF A01.

Residential data collection and analysis undertaken for the US Department of Housing and Urban Development (HUD) Office of Policy Development and Research are presented as part of the first phase in the development of energy performance standards for new construction, under Title III of Public Law 94-385, the Energy Performance Standards for New Buildings Act of 1976. The NAHB Research Foundation has developed base data on the designed energy performance of low-rise residential construction, including single family detached and single family attached homes, multifamily low-rise dwellings and mobile homes, in various climatic regions across the continental US using data collected in 1975 and 1976. The technique used to estimate energy performance from the residential data was essentially a manual steady-state heat transfer method which was computerized. The annual energy performance of each building was estimated using building design data, heat loss and heat gain multipliers, and heating and cooling utilization factors. Heat loss and heat gain factors for each exposure of each residence were calculated using heat loss and heat gain multipliers developed for various construction materials. Heating and cooling utilization factors were developed based on seasonal heating and cooling system efficiencies. The heat gain and heat loss factors, multiplied by the appropriate utilization factor, yielded the energy required to heat and cool the residence for one year. The mean, 20th and 80th percentiles of the designed energy performance of each residential building type, in BTUs per square foot, were tabulated for each climate region.

56835 (NP—23909) **Model to determine the heat demand of domestic buildings for direct electric heating systems.** Hoeltker, K.H. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Elektrotechnik). 17 Dec 1976. 144p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

To analyze the technical and energy-economical aspects, a model house was developed with which the thermal behavior of existing houses can be described. This model covers four forms of energy exchange: heat conduction, convection, radiation, mass exchange. With this model, the effects of the influencing agents on the heating demand of the house are analyzed. The results for selected days are shown. An electrical direct heating system was included in the model. In this, ambient air temperature, wind speed, and global wall radiation proved to be determining parameters. The control of the in-room temperature was found to be the most effective measure to influence the heat power consumption of a building.

56836 (NP—23918) **Directory of refrigerator freezers sorted by type and volume.** (California Energy Commission, Sacramento (USA)). Dec 1978. 48p. NTIS, PC A03/MF A01.

This directory of refrigerators, freezers, and combinations thereof contains the manufacturer, brand name, and model number, along with other pertinent information about each model that has been certified as complying with California regulations that became effective on November 3, 1977. The text of the regulations can be found in the California Administrative Code, Title 20, Chapter 2, Subchapter 4, Article 4. All refrigerators/freezers sold or offered for sale in California on or after November 3, 1978 which have not been certified as complying with the standards are in violation of the regulations.

56837 (NP—23936) **In the bank...or up the chimney. A dollars and cents guide to energy-saving home improvements. 2nd edition.** (Abt Associates, Inc., Cambridge, MA (USA); Technology and Economics, Inc., Cambridge, MA (USA)). Aug 1977. 83p. GPO.

The results of HUD-sponsored research on the many ways to save energy and money while heating and cooling the home are described in this booklet. The energy-saving techniques are applicable for all types of housing. The booklet helps in the decision on whether to do the job yourself or to hire a contractor. Tables are provided to enable you to compute the cost-savings of each method. Specific information is provided on caulking and weatherstripping, installing storm windows, insulating all areas, thermostats, furnaces, air conditioners, and heating and cooling factors.

OFFICE BUILDINGS

56838 (DOE/TIC—10182) **Phase one: base data for the development of energy performance standards for new buildings.** (Brown Associates, Silver Spring, MD (USA)). 12 Jan 1978. 107p. Dep. NTIS, PC A06/MF A01.

Documentation of the sample design used to conduct the survey for Phase I of the HUD Baseline Building Study is provided. The various considerations which were involved in the choice of the details of the sample design used; the details of the sample selection and control; the details of computation procedures for estimates and confidence intervals of the estimates; and an evaluation of the sampling variability actually achieved are covered.

56839 16% saving for electronic vs coil ballast. Murnane, T. *Energy User News;* 4: No. 37, 1, 11(10 Sep 1979).

A three-year DOE-funded test of lighting systems showed that electronic ballasts can save from 16% (for Iota ballasts) to 25% (for Stevens ballasts) more energy than core-and-coil ballasts. The tests included a demonstration that the solid-state ballasts used fewer watts to drive the fluorescent fixtures of a San Francisco office building. The ballasts also failed to cause the maintenance and noise problems predicted by earlier critics. A higher initial cost will be offset by the lower noise and heat-dissipation levels, although some questions of lamp life remain. An electronic ballast market is expected to develop.

56840 Energy conservation study of District State Office Building, La Crosse, Wisconsin. Madison, WI; Wisconsin Dept. of Administration (1977). 48p. (NP—23974). Wisconsin Dept. of Administration, One West Wilson St., Madison , Wisconsin.

The Energy Conservation study of the State Office Building located in La Crosse, Wisconsin, was undertaken to determine measures that could be implemented to reduce the consumption of energy at this facility. An analysis was made of both the operational procedures and the various systems contained within the facility. During the fiscal year of 1975-76, the utility cost for this facility was $13,955 with an additional cost of $889 for water. The basic recommendations in this report, if implemented, will result in an annual savings of $4,585. The resultant energy saved is estimated to be 812 x 10^6 Btu/year, which is a reduction of 28%. This Btu figure is equivalent to 5,800 gallons of oil; 34 tons of coal; or 812,000 cubic feet of gas.

56841 Energy conservation study. Madison, WI; Bureau of Facilities Management (1977). 51p. (NP—23985).

The Energy Conservation study of the State Office Building located in Wisconsin Rapids, Wisconsin, was undertaken to determine measures that could be implemented to reduce the consumption of energy at this facility. An analysis was made of both the operational procedures and the various systems contained within the facility. During the fiscal year of 1975 to 1976 the utility cost for this facility was $19,179 with an additional cost of $2,765 for water The basic recommendations in this report, if implemented will result in an annual savings of $12,270. It should be noted here that the savings figures were developed on new price structures for oil, electrical, and water. The 1975 to 1976 fiscal year figure does not reflect these new costs. For example: oil is up to $.3592/gallon from $.303 for the last six months of 1975; electricity is up to $.036/kWh from $.025 in 1975; water costs will more than double this year with the addition of a sewer charge. The resultant energy saved will be 1,489 x 10^6 Btu/year which is a reduction of 34%. This Btu figure is equivalent to 10,636 gallons of oil; 60 tons of coal; or 1,489,000 cubic feet of gas.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 56838

56842 (TULEA-EX-ARB—1978-191E) **Energy saving measures at a school (Bergnaesskolan) at Luleaa, Sweden: the ventilation equipment.** Drugge, J. (Tekniska Hoegskolan, Lund (Sweden)). 1978. 25p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The possibilities of installing rotating heat exchangers at a school (Bergnaesskolan) at Luleaa, Sweden, were investigated. The work includes the equipment for air conditioning. The thermotechnical part is treated in another report. The profitability of such an installation is analyzed.

56843 Energy conservation survey: Portage Armory 465-02-0001; Waupun Armory 465-06-0020. Madison, WI; Bureau of Facilities Management (1978). 52p. (NP—23984).

The study determines measures that could be implemented to reduce consumption of energy at armory facilities and other facilities similar in construction and use. Operational procedures are analyzed along with the various mechanical systems. Since the usage of space is specialized and many armories serve civil organizations, utilization of space is covered only in the mechanical section where certain areas in a building can be maintained at a lower temperature. Savings will result from changes proposed in general construction, plumbing, electrical, heating, and ventilation.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 56812, 56838, 56858, 56859

56844 (DOE/TIC—10210) **Energy cost reduction for retail florists.** (Department of Energy, Washington, DC (USA)). 15 Dec 1977. 58p. Society of American Florists, 901 N. Washington Street, Alexandria, VA.

Recommendations are made to help retail florists cut the cost of energy in their business operations. It shows how to recognize and act on energy waste in lighting, heating, refrigeration, delivery, and greenhouse operations. Recommendations describe a condition and what techniques to implement in order to achieve savings. An example with qualified savings is given, and suggested follow-up procedures are delineated. The examples are case histories.

56845 (DOE/TIC—10211) **Energy audit for growers: a self-inspection guide to reduce energy costs.** (Department of Energy, Washington, DC (USA)). Feb 1978. 97p. Society of American Florists, 901 N. Washington Street, Alexandria, VA.

This handbook was developed to help wholesale growing operations cut the cost of energy in their businesses. It shows how to recognize and act on energy waste in heating, ventilation, soil sterilizing and watering, artificial lighting, efficient use of space, delivery, and refrigeration.

56846 Energy conservation study. Energy survey of organizational maintenance shops Hayward OMS 465-07-0012 and Madison OMS 465-02-0003. Madison, WI; Wisconsin Dept. of Administration (1978). 36p. (NP—23955). Wisconsin Dept. of Administration, One West Wilson St., Madison , Wisconsin.

The Energy Conservation study of the Organizational Maintenance Shops located in Hayward and Madison, Wisconsin, was undertaken to determine measures that could be implemented to reduce the consumption of energy at these facilities and the other twelve shops. An analysis was made of the building shell and the various mechanical systems contained within these facilities. During the fiscal year 1975-1976, the utility costs for Hayward were fuel oil $2,059 and electricity $718. Utility costs for Madison were fuel oil $2,248 and electricity $1,540. Savings at the twelve other shops would be comparable to the Hayward and Madison shops due to similar construction with the exception of Kenosha and Richard Street at Milwaukee, which have concrete exterior walls.

TRANSPORTATION

REFER ALSO TO CITATION(S) 56791, 56799

56847 Preliminary transportation assessment: southeastern Alaska transportation study. Juneau, AK; Wilbur Smith and Associates ([nd]). 41p. (NP—23932). Alaska State Dept. of Transportation and Public Facilities, Juneau, AK.

A regional transportation plan consisting of air, land, and marine transportation improvements preferred by residents of southeastern Alaska is described. The plan will direct the State in developing needed transportation improvements within the limits of available State resources and funding for the region. Forty-one transportation improvements of an intercommunity nature were identified for preliminary study. The transportation options which involve intercommunity transportation were analyzed for anticipated costs, benefits, and adverse impacts associated with each alternative. The results of this analysis in the form of comparative matrices so that community members can identify the relative impacts and costs of each alternative are presented.

AIR AND AEROSPACE

56848 (AD-A—061746) **An analysis of fuel conserving operational procedures and design modifications for bomber/transport aircraft. Volume I. Executive summary. Final report, 7 June 1976-7 July 1978.** Aggarwal, R. (Dynamics Research Corp., Wilmington, MA (USA). Systems Div.). Jul 1978. Contract F33615-76-C-3104. 24p. NTIS PC A02/MF A01.

Various proposed improvements in the design and operational procedures for bomber/transport aircraft are evaluated. The evaluation is performed in terms of the estimated savings in fuel consumption and in Direct Operating Cost (DOC). As an aid in the evaluation of design modifications, graphs of fuel and DOC savings as a function of the design parameters are developed. These graphs are based on actual mission trajectory data rather than some type trajectory profile. The actual mission data is presented in terms of histograms which provide statistical information concerning altitude, air speed, take-off weight, landing weights, and mission time. Separate analyses are performed on the following aircraft: the B-52G, the B-52H, the KC-135, the C-141, the C-130, and the C-5A.

56849 (N—79-13050) **Analytical evaluation of the impact of broad specification fuels on high bypass turbofan engine combustors. Final report.** Lohmann, R.P.; Szetela, E.J.; Vranos, A. (Pratt and Whitney Aircraft, East Hartford, CT (USA). Commercial Products Div.). Dec 1978. Contract NAS3-20802. 161p. NTIS PC A08/MF A01.

The impact of the use of broad specification fuels on the design, performance durability, emissions and operational characteristics of combustors for commercial aircraft gas turbine engines was assessed. Single stage, vorbix and lean premixed prevaporized combustors, in the JT9D and an advanced energy efficient engine cycle

were evaluated when operating on Jet A and ERBS (Experimental Referee Broad Specification) fuels. Design modifications, based on criteria evolved from a literature survey, were introduced and their effectiveness at offsetting projected deficiencies resulting from the use of ERBS was estimated. The results indicate that the use of a broad specification fuel such as ERBS, will necessitate significant technology improvements and redesign if deteriorated performance, durability and emissions are to be avoided. Higher radiant heat loads are projected to seriously compromise liner life while the reduced thermal stability of ERBS will require revisions to the engine-airframe fuel system to reduce the thermal stress on the fuel. Smoke and emissions output are projected to increase with the use of broad specification fuels. While the basic geometry of the single stage and vorbix combustors are compatible with the use of ERBS, extensive redesign of the front end of the lean premixed prevaporized burner will be required to achieve satisfactory operation and optimum emissions.

RAILWAY

REFER ALSO TO CITATION(S) 56817

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 56817

56850 (DOE/CS—0031/1) **Vanpooling: an update.** Pratsch, L.; Starling, R. (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Sep 1979. 65p. Dep. NTIS, PC A04/MF A01.

This update of A Summary and Description of Existing Vanpool Programs (January 1976) presents in one source the current data on a cross-section of vanpool programs and allows prospective vanpool sponsors to analyze and compare the various approaches used by those programs already in operation. Each program contains a contact name where additional information may be obtained.

56851 (N—79-13370) **The Otto-Engine-Equivalent vehicle concept.** Dowdy, M.W.; Couch, M.D. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Dec 1978. Contract NAS7-100. 36p. NTIS PC A03/MF A01.

A vehicle comparison methodology based on the Otto-Engine Equivalent (OEE) vehicle concept is described. As an illustration of this methodology, the concept is used to make projections of the fuel economy potential of passenger cars using various alternative power systems. Sensitivities of OEE vehicle results to assumptions made in the calculational procedure are discussed. Factors considered include engine torque boundary, rear axle ratio, performance criteria, engine transient response, and transmission shift logic.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 56248, 56250, 56747

56852 (ALO—5076-T1) **IEA steel R and D study. Final report.** (Gordian Associates, Inc., New York (USA)). 31 May 1979. Contract EC-77-C-01-5076. 16p. Dep. NTIS, PC A02/MF A01.

Following a recent IEA meeting of steel industry experts held in Stockholm in May 1979, a number of specific projects have been recommended as forming the basis for a cooperative program of R and D oriented to energy saving in the making of iron and steel. A timetable of work leading up to another meeting (October-November 1979) has been agreed, and this includes the development of detailed project descriptions, as well as the drafting of a proposed implementing agreement with its technical annexes. In summary, five working areas have been identified: surface inspection, surface conditioning, heat recovery, energy conversion and combustion, and material properties. A total of about 20 projects have been suggested, and it is hoped that sufficient detail will be provided on most of these to allow an acceptable implementing agreement to be developed within the next six months.

56853 **Second European congress of industrial maintenance.** Parkes, D. Paris, France; Association of Engineers and Heads of Maintenance (1978). vp. (In several languages). (CONF-7404136—). $70.00.

From 2. European congress of industrial maintenance; Paris, France (24 Apr 1974).

Nineteen papers were presented at the meeting. A separate abstract was prepared for 1 paper. The remaining 18 papers were not in scope for the data base. (LCL)

MATERIALS

56854 (Juel—1553) **Preparation and characterization of ternary Hg$_1$-In$_4$-Mg/sub 0-1/ amalgams. A contribution to an increased luminance of low-pressure fluorescent lamps.** Hilpert, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Angewandte Physikalische Chemie). Nov 1978. 54p. (In German) Dep. NTIS (US Sales Only), PC A04/MF A01.

Eleven new alloys of the composition Hg-In$_4$-Mg/sub n/ (n = 0.1; 0.2; 0.3; ... 1) were prepared in connection with the development of fluorescent lamps having a small consumption of electric energy. The various alloys were prepared by melting Hg, In, and Mg in crucibles made of iron. No chemical interactions between the material of the crucible and the alloys could be observed. The composition of the samples were studied by patterns of polished sections, electron probe microanalysis, x-ray analysis, and differential thermal analysis. According to these investigations the alloys contain the compound MgHg and depending on the temperature and composition one or two other phases consisting of a melt and Hg-In-mixed crystals. The results are discussed regarding the Hg-partial pressure of the various samples and regarding their possible use in fluorescent lamps.

EQUIPMENT AND PROCESSES

56855 (PB—286443) **4-H Tractor Program: learning by doing. D units. Machinery care project.** (National 4-H Tractor Program's Sub-Committee). 1978. 80p. NTIS PC A05/MF A01.

The booklet covers many of the more important jobs which need to be done to keep farm implements in good running condition. It tells how machinery is fastened together; how power is transmitted; how to make adjustments and care for your machinery. Rather than covering a complete machine, each lesson covers a particular job.

56856 (PB—289362) **The impact of energy shortage and cost on irrigation for the High Plains and Trans Pecos regions of Texas. Technical report.** Lacewell, R.D.; Confra, G.D.; Hardin, D.C.; Zavaleta, L.; Petty, J.A. (Texas A and M Univ., College Station (USA). Water Resources Inst.). Sep 1978. Contracts DI-14-34-0001-7091;DI-14-34-0001-7092. 70p. NTIS PC A04/MF A01.

Results derived from three models to evaluate expected effect of increasing fuel price, fuel curtailment and risk are presented for the Texas High Plains and Trans Pecos. Increasing natural gas price could reduce the value of groundwater by 50 percent. In the Trans Pecos, with the assumption that energy prices would rise faster than crop prices, average economic life expectancy of a typical farm is estimated to be about five years. Implication of rising natural gas price is dramatic and emphasizes the serious need to become more efficient in use of irrigation water. Annual savings resulting from improved efficiency in pumping and applying irrigation were estimated to be several million dollars.

56857 (SAN—1257-T2) **Energy savings through use of an improved reduction cell cathode.** Goodnow, W.H. (Kaiser Aluminium and Chemical Corp., Pleasanton, CA (USA)). 1979. Contract EC-76-C-03-1257. 18p. Dep. NTIS, PC A02/MF A01.

Development work during the sixth quarter of the cost sharing contract between the Department of Energy and Kaiser Aluminum and Chemical Corp. is summarized. The project purpose is to develop a wettable and drained Hall cell cathode which will reduce the specific energy consumption of commercial cells by 20 to 25%. During this quarter the material characterization task was expanded to include inspection of TiB_2 components for the 15KA cell restart. That cell was restarted on January 24, 1979, and went through a shakedown and performance monitoring period until the end of the quarter. The engineering and economic study of TiB_2 retrofit into existing cells was carried to the point where a sensitivity type cost analysis was done.

56858 **Some considerations on current investment in glasshouses.** Wall, E.T. (States Horicultural Advisory Service, Guernsey, England). pp 346-355 of Proceedings of the international symposium on controlled-environment agriculture. Jensen, M.H. (comp.). Tucson, AZ; Environmental Research Laboratory (1977).

From International symposium on controlled environment agriculture; Tucson, AZ, USA (7 Apr 1977).

Rapidly escalating fuel costs have underlined the necessity for critical analysis of investment and production methods in heated greenhouse production. Capital, heating, and labor are the major cost items and are reviewed for tomato production in Guernsey. The seasonal price pattern and the high fixed costs of marketing determine that the emphasis remains on early season production. Modifications of growing programs to economize in fuel use by running lower temperatures or delaying sowing are financially unsound. Alternative sources of energy are not economic at present. Heat conservation, by the use of heat retaining screens, is more attractive, but the savings that are likely to be achieved in practice do not appear to justify the capital costs involved. Significant variations exist in the heat loss characteristics of individual glasshouses, and scale is important in initial capital costs and subsequent annual heating costs so that, within conventional practice, there is considerable scope for affecting profitability. Mechanization, apart from

transport operations, has little part to play in greenhouse tomato production. A system of training is used which optimizes the labor requirement of the main routine tasks of trimming, deleafing and harvesting. However, this does not give the best configuration of plants for light interception throughout the crop, and yields may be affected adversely. A layering system to high crop wires can be operated with some saving of labor, but increases in capital and heating costs largely offset the savings. Nevertheless, an improvement in yield potential, not yet established and quantified, would justify the system.

56859 (DOE/TIC—10215) **Energy cost reduction for automotive service facilities.** (Automotive Service Councils, Inc., Elmhurst, IL (USA)). [nd]. 20p. Dep. NTIS, PC A02/MF A01.

This handbook presents helps for automotive service facilities to cut the cost of energy in their business establishments. It shows how to recognize and act on energy waste in: lighting; space heating; and general shop maintenance. Most of the energy use in automotive service shops is for lighting and heating. Lighting for interiors and storage areas may consume from 30 to 70% of total energy costs. Heating and air conditioning costs make up most of the remaining energy outlay. These are important areas for potential savings in auto service shops, and are the major areas of emphasis in this handbook.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 56368, 56758, 56863

56860 (STU—76-5419(Pt.2)) **Suggested measures to achieve a more efficient use of energy at the Oxeloesund Steel Mill, Sweden.** Hardell, R.; Fors, J.; Koelhi, M. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Feb 1978. 32p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

The processes and their energy balance are described. Short discussions of the technical and economical aspects of the proposed actions are presented. Waste heat can be used both for power generation and district heating. The pay off time for an installed power generator is calculated as a function of oil and electricity prices. Using reasonable values, a pay off time of less than 3 years is calculated.

56861 **Proceedings of the international symposium on controlled-environment agriculture.** Jensen, M.H. (comp.). Tucson, AZ; Environmental Research Laboratory (1977). 424p. (CONF-770426—).

From International symposium on controlled environment agriculture; Tucson, AZ, USA (7 Apr 1977).

Separate abstracts were prepared for 12 of the included papers. Three of the papers were also input into the GAP file. (MOW)

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 56819

56862 **Waste management: the contribution of the maintenance engineer.** Patrick, P.K. pp 35-50 of Second European congress of industrial maintenance. Parkes, P. Paris, France; Association of Engineers and Heads of Maintenance (1978).

From 2. European congress of industrial maintenance; Paris, France (24 Apr 1974).

A general picture is presented of the industrial waste management scene, and specifically of practices and regulations in the UK related to the handling and disposal of liquid, solid, hazardous, or toxic industrial wastes. (LCL)

MUNICIPALITIES AND COMMUNITY SYSTEMS

56863 (CONS—5080-1) **Applications of thermal energy storage to process heat and waste heat recovery in the primary aluminum industry. Final report, September 1977-September 1978.** Katter, L.B.; Hoskins, R.L. (Rocket Research Corp., Redmond, WA (USA)). Apr 1979. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

The results of a study entitled, Applications of Thermal Energy Storage to Process Heat and Waste Heat Recovery in the Primary Aluminum Industry are presented. In this preliminary study, a system has been identified by which the large amounts of low-grade waste energy in the primary pollution control system gas stream can be utilized for comfort heating in nearby communities. Energy is stored in the form of hot water, contained in conventional, insulated steel tanks, enabling a more efficient utilization of the constant energy source by the cyclical energy demand. Less expensive energy storage means (heated ponds, aquifers), when they become fully characterized, will allow even more cost-competitive systems. Extensive design tradeoff studies have been performed. These tradeoff studies indicate that a heating demand equivalent to 12,000 single-family residences can be supplied by the energy from the Intalco plant. Using a 30-year payback criterion (consistent with utility planning practice), the average cost of energy supplied over the system useful life is predicted at one-third the average cost of fossil fuel. The study clearly shows that the utilization of waste energy from aluminum plants is both technically and economically attractive. The program included a detailed survey of all aluminum plants within the United States, allowing the site specific analyses to be extrapolated to a national basis. Should waste heat recovery systems be implemented by 1985, a national yearly savings of 6.5 million barrels of oil can be realized.

56864 (NE-PROJ—2060251) **Hot water pipelines for long-distance heat distribution.** (Sydkraft AB, Malmoe (Sweden)). Jan 1979. 421p. (In Swedish). Dep. NTIS (US Sales Only), PC A18/MF A01.

The aim of the work is to analyze problems which occur in connection with long-distance heat distribution. Deeper knowledge in this field is of importance in connection with the use of waste heat and for regional collaboration concerning district heating. The long distances will cause pressure transients in the pipes. A computer program, which simulates these pressure transients, is described. With this program most events in the system can be simulated and the consequences on the different components of the system can be calculated. Calculations of the strength of pipe bendings have also been performed. Finally it is pointed out that some kind of safety policy has to be worked out in this field.

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 56816

MUNICIPAL WASTE MANAGEMENT

56865 (BNL—51065) **Preliminary assessment of the prospects for use of refuse-derived fuel in Maryland.** Metz, W.C.; Shyer, J.; Edgecomb, K. (Brookhaven National Lab., Upton, NY (USA)). Feb 1979. Contract EY-76-C-02-0016. 83p. Dep. NTIS, PC A05/MF A01.

The deployment problems of refuse derived fuel (RDF) production in Maryland are examined. Problems experienced by the pyrolysis plant in Baltimore City and the resource recovery plant in Baltimore County are cited. Maryland's municipal solid waste problems are discussed with emphasis on the major components of the municipal solid waste stream, e.g., volume, composition, and location; collection methods used; present and long-range disposal methods; and regulations and ordinances. The generic social and legal constraints to RDF production are described. The problems of RDF technology deployment in Maryland, i.e., county and state RDF energy potential, institutional barriers to RDF production and use, remitting requirements for new RDF production and use facilities, water quality issues of RDF production and use, air quality issues of RDF production and use, and recommendations for initiating RDF production and use are discussed.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 56741, 56760, 56761

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 56790

56866 (CONF-7811102—2) **Scaling of some flowfields with flames.** Bracco, F.V. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). 1978. Contract EC-77-S-02-4191. 49p. Dep. NTIS, PC A03/MF A01.

From International symposium on combustion modeling in reciprocating engines; Warren, MI, USA (6 Nov 1978).

A mathematical model for flowfields with flames is developed and applied to the combustion kinetics of internal combustion engines.

56867 **Pulsed-illumination, closed-circuit television system for real-time viewing of engine combustion and observed cyclic variations.** Steinberger, R.L.; Marden, W.W.; Bracco, F.V. Contract EC-77-S-02-4191. Warrendale, PA; Society of Automotive Engineers, Inc. (1979). 16p. (CONF-790216—5).

From 1979 SAE Congress and Exposition Engine Modeling Session; Detroit, MI, USA (26 Feb 1979).

A closed-circuit television technique has been developed for the real-time viewing and recording of combustion and related processes in internal combustion engines. The technique has been applied to a transparent piston, transparent head engine, and shadowgraphs of combustion chamber events have been observed and recorded. The technique is particularly suited for the study of changes in the combustion process due to variations of engine parameters such as mixture ratio, load, speed, spark timing, injection initiation, etc., since the changes can be observed and recorded at the same time that they occur. A brief and qualitative study of flame and pressure cyclic variations is reported and discussed as an example of an application for which the television technique is particularly suited.

SPARK-IGNITION

56868 (COO—4191-2) **Combustion optimization studies for stratified charge and diesel engines. Progress report, October 1, 1978-September 30, 1979.** Steinberger, R.L.; Bracco, F.V. (Princeton Univ., NJ (USA)). Aug 1979. Contract EC-77-S-02-4191. 9p. Dep. NTIS, PC A02/MF A01.

Progress to date is reasonably within the contract schedule in that: (1) the transparent-piston, transparent-head engine is in routine use for visualization experiments; (2) the gaseous fuel injector is routinely used with gaseous propane as a fuel injected into the motored engine; (3) high speed filming and short duration pulsed light single exposure techniques are being used to obtain shadow and schlieren records of gaseous and liquid jets; (4) an LDV system for measuring in-cylinder velocities has been implemented and data is presently being taken and analyzed; (5) engine cylinder pressure data can now be taken and reduced with the minicomputer; and an infrared emission absorption technique has been used to measure engine cylinder temperature; (6) an alternative approach to the modeling of gaseous jets has yielded a characteristic time for steadying of the jet, which in the long run should allow a more efficient computational procedure; (7) work on the definition of appropriate equations for thick sprays has continued; (8) two DISC meetings have been attended, one of which was hosted by Princeton, and the results of the program have been made known to researchers and automotive industries; and (9) the pulsed illumination television system has been successfully used to obtain visual data on engine cyclic variations.

56869 (PB—289959) **Ron-increased compression ratio engine demonstration (91).** Godici, P.E.; Kraus, B.J. (Exxon Research and Engineering Co., Linden, NJ (USA). Products Research Div.). Oct 1978. Contract EPA-68-03-2162. 624p. NTIS PC A99/MF A01.

This program was an experimental effort to evaluate several methods of reducing the octane requirement of a 350 CID Chevrolet engine (1975 California model). Increased squish and two spark plugs per cylinder did not provide the expected gains in this particular application. Aluminum heads and a knock-actuated spark control system were identified as potential methods of reducing octane requirement. The spark control system was incorporated into a vehicle emission control system to enable the use of higher compression ratio heads without substantial losses in emission control and with a gain in fuel economy.

DIESEL

REFER ALSO TO CITATION(S) 56868

56870 (COO—4449-2) **Combustion of multicomponent fuel droplets. Final technical report.** Homan, H.S.; Sirignano, W.A. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). Jul 1979. Contract EC-77-S-02-4449. 28p. Dep. NTIS, PC A03/MF A01.

The subject of the experimental and theoretical investigation is the vaporization and burning of liquid fuel droplets which contain more than one chemical component. The objective is the prediction of the transient rate of changes in chemical composition of multicomponent liquid fuel droplets during vaporization and burning in convective flow. The predictions will be compared with experimental measurements and multicomponent fuel droplets of small size (100 to 300 μm) will be collected from a high velocity (10 to 50 m/s), high temperature (300 to 1000°K) laminar gas flow. Investigations will be started to determine methods of modeling the chemical kinetics of droplet pyrolysis, and attempts will be made to measure the composition changes in burning droplets of heavy fuels. The research will provide a model of droplet burning which is more relevant to droplet vaporization and combustion in fuel sprays than the droplet combustion models which assume spherical symmetry, single-component fuel, and constant droplet properties. The model will impact the models of combustion in diesel engines, gas turbines, and furnaces - especially for the heavy shale- and coal-derived fuels.

TURBINE

REFER ALSO TO CITATION(S) 56870

56871 (DOE/NASA/0004—79/1) **Single shaft automotive gas turbine engine characterization test.** Johnson, R.A. (Detroit Diesel Allison, MI (USA)). Sep 1979. Contract EC-77-A-31-1040. 104p. (NASA-CR—159654). Dep. NTIS, PC A06/MF A01.

AGT-2 is a single-shaft, variable geometry automotive gas turbine engine, which was designed and built by Detroit Diesel Allison (DDA) during 1973-1974. This corporate-funded engine was sized at 167.8 kW (225 hp) for application in future General Motors' (GM) automobiles. The program was carried to the point of initial engine test, but then it was suspended because the energy crisis indicated that engine power was too large for replanned future cars. Although undeveloped, the engine was an asset because of its unique single-shaft configuration and variable geometry components. To utilize this asset for gaining information valuable to the future Department of Energy (DOE) automotive gas turbine program, the National Aeronautics and Space Administration (NASA) and DDA agreed to conduct a performance characterization test. Under NASA Contract DEN 3-4 the engine was rebuilt in a nonrecuperative configuration and was tested for approximately 49 hr between June and December 1978. The purpose of this testing was to characterize the performance of a single-shaft engine incorporating wide-range, variable geometry components. Additionally, the test results were to be used to verify engine modeling techniques using a digital computer program with component rig test performance maps. They were also used to compare component performance in the engine with their performance in rig testing. The test program explored the following areas: (1) inlet guide vane mapping; (2) best specific fuel consumption (SFC) mapping; (3) idle optimization; (4) low power performance; and (5) simulated fixed geometry. Results of the testing are presented.

ELECTRIC-POWERED SYSTEMS

56872 (CONF-790803—48) **Charging system for the LiAl/FeS electric vehicle battery.** DeLuca, W.; Chilenskas, A.; Hornstra, F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

The successful application of LiAl/FeS batteries for electric vehicle (EV) propulsion requires an efficient, low-cost, and unique charging system. The system must replace the bulk charge to the battery and also equalize the charge in the individual cells without exceeding a predetermined electrochemical cell voltage limit. Various techniques have been developed over the past three years at ANL and are routinely employed to perform electronic cell equalization. The charging scheme selected for the EV battery application employs a current-controlled main charger and current bypass circuits which shunt charge current around individual cells for equalization. A proof-of-concept charging system has been built which accommodates batteries of up to six cells. Tests have been performed on both LiAl/FeS and lead-acid batteries. The system is described, operational data presented, and plans for a full-scale 26 kW.hr LiAl/FeS battery charging system outlined. This charging system, which incorporates electronic cell equalization, may offer advantages to other types of battery systems, such as: (1) reduced generation of gases; (2) reduced water consumption; (3) cleaner battery containers; (4) reduced maintenance; and (5) increased battery life.

56873 (DOE/NASA/1044—79/4) **Performance of a 22.4-kW nonlaminated-frame dc series motor with chopper controller.** Schwab, J.R. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Sep 1979. Contract EC-77-A-31-1044. 27p. (NASA-TM—79252). Dep. NTIS, PC A03/MF A01.

Very little performance data is available for chopper controlled dc series motors as used in battery powered electric vehicles. This report presents performance data obtained through experimental testing of a 22.4-kW (30 hp) traction motor using two types of excitation: ripple-free dc from a motor-generator set for baseline data and pulse-width modulated (chopped) dc as supplied by a battery and chopper controller. For the same average values of input voltage and current, the power output was independent of the type of excitation. However, at the same speeds, the motor efficiency at low power output (corresponding to low duty cycle of the controller) was 5 to 10 percentage points less on chopped dc than on ripple-free dc. This apparent discrepancy illustrates that for chopped dc waveforms, it is incorrect to calculate input power as the product of average voltage and current. The chopped dc locked-rotor torque was approximately 1 to 3% greater than the ripple-free dc locked-rotor torque for the same average values of current.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 56780, 56786, 56788, 56789, 56790, 56791, 56792, 56796, 56797, 56798, 56799, 56800, 56801, 56802, 56803, 56804, 56805, 56806, 56869

MATERIALS

REFER ALSO TO CITATION(S) 55967

METALS AND ALLOYS

56874 (ORNL—5485, pp 41-47) **High-temperature chemistry and thermodynamics of structural materials.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

The primary thrust has been shifted from chemistry in support of fusion reactor technology toward chemistry of structural materials at high temperatures. Studies of hydrogen isotope-lithium equilibria were concluded and studies of the thermodynamics of microphases in alloys above 5°C begun. Studies of tritium permeation through and steam oxidation of construction materials (Incoloy 800 at high temperature have continued. Analysis of the oxidation products from the H_2O-alloy reactions has been an increased effort and will continue. Such analysis permits identification of the oxides and the corrosion reactions, in contrast to most other corrosion studies where only weight changes are measured. Materials that form hydrides at relatively low temperatures and that release hydrogen at elevated temperatures continue to be investigated as candidate materials for extraction and/or storage of hydrogen. 5 figures, 4 tables.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 56504, 56734, 56895, 56905

56875 (CONF-780943—2) **Conversion of isotope compounds to metal by reduction-distillation methods.** Kobisk, E.H. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From Conference of the International Nuclear Target Development Society; Munchen-Garching, F.R. Germany (11 Sep 1978).

Because isotopes in metal form provide physicists with mononuclidic targets essentially void of extraneous or interfering nuclei in two-body experiments, conversions of compounds to metals warrant extensive study. Furthermore, having isotopes in pure metallic form permits (in many cases) physical manipulations to be performed so as to convert bulk material into suitable target configurations: thin foils, wires, castings, spheres, and even colloidal suspensions. Physical properties of metals are extensively influenced by small impurity concentrations; therefore, whatever conversion method is applied, it must preserve and/or create an ultrapure product. This paper discusses the application of the reduction of a solid compounded isotope, followed by metal distillation into a noncontaminating collector vessel. A variety of isotope metal vapor condensation-collection methods and subsequent treatment of the product to form various physical forms are discussed. Unfortunately, no single collection technique is applicable to all elements. Limitations of this technique with regard to reducible cations other than those noted earlier are discussed, together with the consequences of volatilization of some metal suboxides in this process. 11 figures.

56876 (CONF-7904106—1) **Anode and cathode geometry and shielding gas interdependence in GTAW.** Key, J.F. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 8p. Dep. NTIS, PC A02/MF A01.

From 61. AWS annual meeting; Los Angeles, CA, USA (14 Apr 1979).

Parametric analyses and high-speed photography of the interdependence of electrode (cathode) tip geometry, shielding gas composition, and groove (anode) geometry indicate that spot-on-plate tests show that blunt cathode shapes have penetration effects similar to addition of a high ionization potential inert gas (such as helium) to the argon shielding gas. Electrode shape and shielding gas composition effects are not synergistic. The time required to develop a given penetration is a function of anode and cathode geometry and shielding gas composition, in addition to other essential welding variables. Spot-on-plate tests are a valid analysis of radical pulsed GTAW. Bead-on-plate tests are a valid analysis of mild pulsed or constant current GTAW.

56877 (SAND—79-0478) **Hot-dipped tin-zinc on U-0.75 w/o Ti.** Weirick, L.J. (Sandia Labs., Albuquerque, NM (USA)). Sep 1979. Contract EY-76-C-04-0789. 46p. Dep. NTIS, PC A03/MF A01.

Conventional Zn galvanizing of U-0.75 Ti results in nonuniform coatings and reduced elongation because of thermal aging of the surface of the U-Ti. A lower melting material which would give sacrificial galvanic protection to the U-Ti was found in the Sn-Zn alloy system. The present work describes: (1) the metallography of the Sn-Zn system, (2) the electrochemistry of the Sn-Zn system with respect to U-Ti, (3) the mechanics of applying a Sn-Zn coating to U-Ti, (4) salt spray corrosion test results of various Sn-Zn alloys applied to U-Ti coupons, and (5) mechanical property tests of coated U-Ti tensile bars. An 80 Sn-20 Zn alloy (MP-280°C) was chosen for the galvanizing study because of its lower melting point. The results showed that all alloys of the Sn-Zn system galvanically protected the U-Ti in salt fog environments. The lack of a suitable low temperature flux prevented the operation of the Sn-Zn bath at its optimum temperature and low elongations were obtained with this coating system.

56878 (RDT-M—2-6T(8-79)(Rev.)) **Martensitic stainless steel (Type 403) forgings (ASME SA-182 with additional requirements).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Aug 1979. Contract W-7405-ENG-26. 11p. RSO.

This standard covers martensitic stainless steel (Type 403 modified) forgings for nuclear and associated applications. Material shall conform to the applicable requirements of ASME SA-182 as modified by Code Case 1337; to the requirements of the ASME Boiler and Pressure Vessel Code (ASME Code), Section III, Article NB-2000; and to the additional requirements of this standard.

56879 (RDT-M—7-3T(8-79)(Rev.)) **Alloy steel bars and shapes (ASME SA-479 with additional requirements).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Aug 1979. Contract W-7405-ENG-26. 14p. RSO.

This standard covers alloy steel bars and shapes for nuclear and associated applications. Material shall conform to the requirements of ASME SA-479; to the requirements of the ASME Boiler and Pressure Vessel Code (ASME Code), Section III, Article NB-2000; and to the additional requirements of this standard.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 56518, 56545, 56903, 56917, 57225

56880 **Fatigue reliability of structural members under combined axial mean and alternating stresses for AISI 1018, 1038, 4130 and 4340 steels.** Kececioglu, D. (Arizona Univ., Tucson (USA)). pp L4/6 1-15 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The failure governing strength distributions of round specimens subjected to a mean axial stress onto which alternating tensile and compressive axial stresses are superimposed, for 10^6 and $2x10^6$ cycles of operation, are determined. AISI 1018, 1038, 4130 and 4340 steel, 3/8-in. diameter, specimens are tested on an axial, Baldwin-Lima-Hamilton Universal Fatigue Testing Machine. Staircase-testing is used to determine the endurance strength distributions at various ratios of alternating to mean tensile stresses. Testing is accomplished at a sufficient number of ratios to enable the construction of a distributional, statistical Goodman strength diagram for each one of the four steels. A digital computer program of the Reliability Engineering Research Laboratory at The University of Arizona, Program LEAST, is used to determine the equation of the distributional Goodman diagram which best fits the loci of the experimental data at stress ratios between zero and infinity.

56881 (CONF-790801--3) **Dislocation model for twinning and fracture and its application to H.C.P. metals.** Yoo, M.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on the strength of metals and alloys; Aachen, F.R. Germany (Aug 1979).

A dislocation model for deformation twinning and cleavage fracture is developed based on the dislocation theory of fracture and the anisotropic elasticity theory of dislocations. The extension of a Mode-I crack and a deformation twin is treated in a unified manner in terms of the surface energy, the twin boundary energy, and the applied stress state. A criterion is established for predicting twin nucleation or crack initiation and is applied to sixteen hexagonal metals.

56882 (CONF-790863—1) **Laser induced redistribution of ion implanted and surface deposited B in silicon: A SIMS study.** Christie, W.H.; Warmack, R.J.; White, C.W.; Narayan, J. (Oak Ridge Nation-

al Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A04/MF A01.

From 2. international conference on secondary ion mass spectrometry; Palo Alto, CA, USA (26 Aug 1979).

SIMS investigations have shown that pulsed laser annealing of ion implanted and surface deposited silicon leads to significant dopant redistribution. Comparison of calculated profiles to SIMS determined profiles provides strong evidence that the laser annealing mechanism involves melting of the crystal, diffusion of dopants in liquid silicon, followed by epitaxial regrowth.

56883 Neutron scattering study of premartensitic phases of TiNi (Fe). Salamon, M.B.; Meichle, M.; Wayman, C.M.; Hwang, C.M.; Shapiro, S.M. (University of Illinois, Urbana, Illinois 61801). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 223-225(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

The premartensitic phases of TiNi (Fe) have been studied by means of neutron diffraction, specific heat, and electron microscopy. Evidence for an incommensurate charge density wave has been found, with a wavevector near, but not at, (h/3, k/3, 0) positions. A lock-in transition occurs at lower temperatures, accompanied by the formation of needle-shaped domains oriented along [110] directions.

56884 Observation of superstructure in α-U near 43 K. Smith, H.G.; Wakabayashi, N.; Crummett, W.P.; Nicklow, R.M.; Lander, G.H.; Fisher, E.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 226-228(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

A lattice dynamics study of α-U at room temperature revealed a pronounced dip in the Σ_4 Lo mode at a wavevector zeta=0.475. Additional studies at low temperatures showed this mode to soften considerably. Below 60 K elastic peaks appear near (h+1/2, k,l), increasing in intensity to a maximum at 10.4 K, the lowest temperatured studied. The current tentative interpretation is the xoexistence of two phases of uranium, the α phase, and a similar, but slightly distorted, α^1 phase with a sinusoidal modulation in the x-direction.

56885 Electron microscopy of spinodal structures at high resolution. Gronsky, R.; Thomas, G. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory,). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 266-268(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

The modulated structure resulting from spinodal decomposition in a Au-Ni alloy has been studied by lattice imaging electron microscopy. Utilizing optical diffraction analysis to determine optimum imaging conditions, the method permits both the wavelength and amplitude of the composition variation to be directly determined at an atomic plane level.

56886 Order parameter of holmium in a magnetic field. Tarvin, J.A.; Eckert, J. (Brookhaven National Lab., Upton, NY (USA)). *Solid State Commun.;* **30**: No. 6, 375-379(May 1979).

The order parameter of the second order magnetic phase transition in Ho at 131 K has been measured in a magnetic field by neutron diffraction. It was expected that the applied field would change the number of components (n) of the order parameter from four to two. Such a change would be visible in the order parameter exponent β. However, in a field of 40 kOe, β is found to be 0.38 +- 0.02, in agreement with the zero field measurement and with an n = 4 model and in contradiction to an n = 2 model.

56887 Microstructure and transient creep in an austenitic stainless steel. Ajaja, O.; Ardell, A.J. (California Univ., Los Angeles (USA). Dept. of Materials). *Philos. Mag., A;* **39**: No. 1, 65-73(Jan 1979).

The dislocation substructures associated with normal and inverted transient creep in annealed and prestrained type 304 austenitic stainless steel were investigated using transmission electron microscopy. Normal primary creep was accompanied by subgrain formation, a process which was accelerated by prestraining. A prolonged accelerating creep stage was observed under certain test conditions. The associated microstructures revealed that this type of transient creep was also accompanied by subgrain development and a reduction in the free dislocation density. It is concluded that knowledge of the evolution of the dislocation microstructures during transient creep cannot be used to predict whether creep is accelerating or decelerating.

56888 Observations on the development of secondary defects in heavily damaged ion-implanted (100) and (111) silicon. Seshan, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Radiat. Eff.;* **40**: No. 1-2, 29-35(Jan 1979).

Secondary defects produced by the annealing wafers of (100) and (111) silicon, implanted to a high dose (10^{16} to 10^{20} ions/cm^3), were investigated using weak-beam electron microscopy. When annealed, the liquid-nitrogen multiple-voltage implanted (111) wafers showed a high density of faults, twins and dislocation tangles. Below this layer stacking fault tetrahedra were found. This is the first report of their existence in ion-implanted silicon. A meandering perfect dislocation network was found in all (100) and (111) implants where the amorphous layer does not extend to the top surface. A model is proposed to explain these observations, based on the influence of stresses arising from damage on the defects nucleated at the crystalline 'amorphous'interface.

56889 Microstructural effects on mechanical properties data for elevated-temperature reactor design. Klueh, R.L.; Brinkman, C.R.; Sikka, V.K. (Oak Ridge National Lab., TN (USA)). pp L9/8 1-9 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

To develop the constitutive equations for materials to be used for elevated-temperature design of nuclear reactors and reactor components, substantial amounts of mechanical properties data are required. The data are generally obtained from a single well-characterized heat of material. In addition to this requirement, designers require handbook values for mechanical properties over the temperature range of interest. Such a data compilation from various heats of materials inevitably shows considerable data scatter - generally termed heat-to-heat variation - and requires a statistical treatment. The authors are presently generating mechanical property design data for types 304 and 316 stainless steels and 2 1/4 Cr-1 Mo-steel. In addition to the determination of design data on single heats of the steel, they are also examining mechanical property data variation. One of the objectives of this work is the acquisition of an understanding of the cause of mechanical properties variations from heat-to-heat.

56890 Microstructure and low-cycle fatigue behavior of Inconel 718. Wu, P.C.S. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). pp L9/9 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 55969, 56187, 56191, 56264, 56394, 56419, 56420, 56463, 56464, 56483, 56486, 56487, 56489, 56492, 56509, 56510, 56511, 56518, 56525, 56528, 56529, 56530, 56541, 56544, 56575, 56576, 56618, 56678, 56719, 56878, 56879, 56887, 56889, 56890, 56917, 56918, 56924

56891 (CEGB-RD/B/N—4338) **Effect of variations in carbon activity on the carburization of austenitic steels in sodium. Exploratory tests.** Gwyther, J.R.; Hobdell, M.R.; Hooper, A.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jul 1978. 23p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Experience has shown that the liquid sodium coolant of fast breeder reactors is an effective carbon-transport medium; the resulting carburization of thin austenitic stainless steel components (eg IHX and fuel cladding) could adversely affect their mechanical integrity. The degree and nature of steel carburization depend, inter alia, on the carbon activity of the sodium environment. Exploratory tests are described in which specimens of austenitic stainless steel were carburized in sodium, the carbon activity of which was continuously monitored by a BNL electrochemical carbon meter. The sodium carbon activity was initially high, but decreased with time, simulating conditions equivalent to plant start-up or coolant clean-up following accidental oil ingress. The extent and nature of steel carburization was identified by metallography, electron microscopy, X-ray crystallography and chemical analysis.

56892 (CONF-790801—4) **Deformation hardening of type 304 stainless steel at elevated temperature.** Turner, A.P.L. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 9p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on the strength of metals and alloys; Aachen, F.R. Germany (Aug 1979).

Samples of Type 304 SS were hardened by various deformation paths. The mechanical behavior of these predeformed samples was characterized by their behavior in tensile tests. Dislocation structure was examined by TEM. Behavior during the prior deformation hardening path was analyzed for indications that the state of the material was changing. Results support the conclusion that more than one state parameter is required to characterize the material.

56893 Localization of plastic work at voids and inclusions in ductile fracture. Nemat-Nasser, S.; Taya, M. (Northwestern Univ., Evanston, IL (USA). Dept. of Civil Engineering). pp L9/7 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56894 Order effect of strain applications in low-cycle cumulative fatigue at high temperatures. Bui-Quoc, T.; Biron, A. (Ecole Polytechnique, Montreal, Quebec (Canada)). pp L9/2 1-10 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Recent test results on cumulative damage with two strain levels on a stainless steel (AISI 304) at room temperature, 537 and 650°C show that the sum of cycle-ratios can be significantly smaller than unity for decreasing levels; the opposite has been noted for increasing levels. As a consequence, the use of the linear damage rule (Miner's law) for life predictions is not conservative in many cases. Since the double linear damage rule (DLDR), originally developed by Manson et al. for room temperature applications, takes the order effect of cyclic loading into consideration, an extension of this rule for high temperature cases may be a potentially useful tool. The present paper is concerned with such an extension.

56895 (INIS-mf—4470, pp vp) **Effect of annealing temperature on the mechanical properties of zircaloy-4 cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The mechanical properties of zircaloy cladding materials are sensitive to those fabrication variables which have an effect on the preferred crystallographic orientation or texture of the finished tube. The effect of one such variable, the final annealing temperature, on various mechanical properties is examined using tube reduced zircaloy-4 fuel rod cladding annealed at temperatures from 905F to 1060F. This temperature range provides cladding with varying degrees of recrystallization including full recrystallization. Hoop creep characteristics of zircaloy cladding were studied as a function of the annealing temperature using closed-end internal pressurization tests at 750F and hoop stresses of 10, 15, 20 and 25 ksi. The critical annealing temperature at which a minimum creep strain occurs decreases as the applied stress increases. An additional test at 700F and 30 ksi hoop stress was conducted to demonstrate that the critical annealing temperature is essentially independent of the test temperature. Plausible explanations based on differing substructures developed in cold-worked stress-relieved material are forwarded. The effect of annealing temperature on the room temperature mechanical anisotropy parameters, R and P, was studied. R-parameters were determined from in situ transverse strain gage measurements in uniaxial tensile tests. P-parameters were calculated from uniaxial test data (R and yield stress) and hoop yield stress determined in biaxial, closed-end internal pressurization tests.

56896 (INIS-mf—4470, pp vp) **Development of anisotropic plasticity for zircaloy-2.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A series of experiments on doubly notched specimens were performed. These specimens produce a complex stress field in the tension-tension quadrant across the ligament and permit direct measurements of the notch opening displacement. In addition, the post-yield behavior of the doubly notched specimen is very sensitive to the degree of anisotropy. For an essentially plane strain specimen, the measured notch opening displacement as a function of the applied load is in good agreement with the computed relationship which employed the above anisotropic formulation. The results based on the isotropic formulation significantly underestimated the post-yield strength of the specimen.

56897 (INIS-mf—4470, pp vp) **New high temperature deformation model for zircaloy clad ballooning under hypothetical LOCA conditions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Assuming Zircaloy clad ballooning occurs predominantly by thermal activated secondary creep, generally a power law is applied to describe the creep rate analytically. According to Norton the creep rate is taken as a power function of the cladding hoop stress multiplied by a numerical constant which is determined by the cladding structural properties and a Boltzmann factor including the creep activation energy, the gas constant and the cladding temperature respectively. As is well known, the stress exponent is not a constant value in the total range of LOCA stresses, but increases steadily with stress. This difficulty is avoided by introducing into the Norton law a plastic flow-factor including a limiting stress, which was derived by G. Senski using plastic crack models from Dugdale and Irwin. For LOCA applications the limiting stress is identified with the burst stress, which is experimentally determined. A total number of about 280 directly heated KWU burst tests including two types of experiments: (i) controlled temperature transient tests, (ii) creep rupture tests, are used to fit the burst stress of KWU zircaloy tubes simulating the whole range of LOCA temperatur.

56898 (INIS-mf—4470, pp vp) **Analysis of the ballooning deformation of an internally pressurized thin-wall tube during fast thermal transients.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A large-strain, time-dependent thermoplastic analysis of ballooning deformation was developed. The true (or lagorithmic) strains, the Von Mises yield criterion and Prandtl-Reuss flow rules were used. The constitutive equation was expressed in terms of the temperature, effective stress, strain and strain rate. Material isotropy was assumed as a first approximation; note that at high temperatures even zircaloy tends to lose a substantial amount of its low-temperature anisotropy. The axisymmetry of ballooning was also assumed, which has actually been verified by numerous experiments to be accurate throughout the course of ballooning, except in the final stage when rupture is imminent. The thin-shell approximation was made, which proved to be adequate for the standard fuel claddings and which was advantageous in that the averaged state of stress was rendered determinate. The analysis led to a set of non-linear ordinary differential equations, which was then integrated by a fifth-order Runge-Kutta routine. The general formulation allows for a direct interpretation of the experimentally-observed effects of the heating rate and cladding axial constraints on the ballooning behavior. Its implications on the flow-blockage and cladding-rupture evaluations were discussed. The analysis was applied to zircaloy claddings subjected to simulated thermal transient conditions. Most of the required material properties were taken from the existing uniaxial tensile test data. Analyses were performed at a uniform heating rate of 115°C/sec with internal pressures ranging from 100 to 1200 psi. Satisfactory agreement was obtained between the predictions and the diametral strain-time data available from tube-burst tests.

56899 (JAERI-M—7629) **High-temperature strength of Nb-1%Zr alloy for irradiation-capsules inner-shell.** Nomura, Y.; Nakata, H.; Tanaka, M.; Fukaya, K. (Japan Atomic Energy Research Inst., Tokyo). Apr 1978. 35p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Coated fuel particles in capsules will be irradiated at about 1600°C in JMTR. Nb-1%Zr alloy was chosen for inner shell material of the capsules because of its sufficient strength at 1000°C and low induced radioactivity. Nb-1%Zr ingot produced by electron beam melting was formed into seamless tubes by hollowing and swaging, followed by annealing. Creep test in helium flow and tensile test in vacuum were made to examine mechanical strength of the Nb-1%Zr tubes at 1000°C. Following are the results; 1) 0.2% yield stress at 1000°C is about 6 kg/mm². 2) 3000 hr creep rupture stress at 1000°C is about 6 kg/mm².

56900 (ORNL/BRP—79/4) **Modified 9 Cr-1 Mo steel development program progress report, March 31, 1979.** DiStefano, J.R. (comp.). (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 210p. AT.

Research concerning Cr-Mo steel for use in LMFBR plant components is described. Creep, weld filler metal development, weldability, tensile testing, charpy v-notch toughness studies, thermal aging, corrosion, hydrogen embrittlement, precipitate extraction and identification, and stress rupture testing are reported. (FS)

56901 Phenomenological theory of transient creep. Ajaja, O.; Ardell, A.J. (California Univ., Los Angeles (USA). Dept. of Materials). *Philos. Mag., A;* **39**: No. 1, 75-90(Jan 1979).

A new creep theory is proposed which takes into account the strain generated during the annihilation of dislocations. This contribution is found to be very significant when recovery is appreciable, and is mainly responsible for the decreasing creep rate associated with the normal primary creep of class II materials. The theory provides excellent semiquantitative rationalization for the types of creep curves presented in the preceding paper. In particular, the theory predicts a change in the shape of the primary creep curve from normal to inverted as recovery becomes less important, i.e. as the applied stress and/or temperature decrease(s). It also predicts a minimum creep rate under certain circumstances, hence pseudo-tertiary behaviour. These different types of creep curves are predicted even though the net dislocation density decreases monotonically with time in all cases. Qualitative rationalization is presented for the inverted transient which always follows a stress drop in class II materials, as well as for the inverted primary and sigmoidal creep behaviour of class I solid solutions.

56902 Computer simulation of the Charpy V-notch toughness test. Norris, D.M. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Eng. Fract. Mech.;* **11**: No. 2, 261-274(1979).

The impact of a striker with the ASTM Type A Charpy V-Notch specimen has been calculated. An elastic-plastic constitutive law with J_2-flow theory and isotropic hardening was used to model A-533 Grade B class 1 steel at 100°C. Large strain and rotation are accounted for. It was found that the notch stress-strain state was independent of the three-point loading type (round- or flat-tip striker or pressure push) and was most strongly correlated with notch-opening displacement. The dynamic stress-strain state at the time of fracture initiation was obtained by comparing the calculated deformed shape with that obtained in interrupted Charpy-V-notch tests where cracking had started. This time agreed with a computed prediction of fracture initiation obtained using a computer model of material damage. Cracking starts at the notch at about 40% of the maximum load found in an instrumented Charpy test. The distribution and partition of specimen energy has also been calculated. Adiabatic heating and strain rate are discussed.

56903 Heat treatment effects on creep and rupture behavior of annealed 2.25 Cr-1 Mo steel. Klueh, R.L. (Oak Ridge National Lab., TN). *Metall. Trans., A;* **9**: 1591-1598(Nov 1978).

The strength of 2 1/4 Cr-1 Mo steel depends on the microstructure, which, in turn, depends on the heat treatment. In the fully annealed and isothermally annealed conditions, the microstructure is primarily proeutectoid ferrite with varying amounts of bainite and pearlite. The relative amounts of the latter constituents depend on the cooling rates during the anneal. The creep and rupture properties were determined for steel plates (from a single heat) given three different annealing treatments: two were fully annealed, but cooled at different rates from the austenitizing temperature, and the third was isothermally annealed. Properties were determined at 454, 510, and 566°C. At 454 and 510°C, the cooling rate had a significant effect on the creep and rupture properties, with the material cooled fastest being the strongest. Although at 510°C strengths at short rupture times differed widely, the properties approached a common value at longer rupture times. The properties differed very little at 566°C, even for short rupture times. The effect of heat treatment was concluded to be the result of interaction solid solution hardening, a dislocation-drag process. This process gave rise to nonclassical creep curves (as opposed to classical curves with single primary, secondary, and tertiary stages). By examining the creep-curve shape, it was possible to interpret the heat treatment effects on the creep-rupture properties.

56904 Non-linear fracture mechanics. Burns, S.J.; Pollet, J.C.; Chow, C.L. (Univ. of Rochester, NY). *Int. J. Fract.;* **14**: No. 3, 311-326(Jun 1978).

The fracture of solids is analyzed using the formalism of equilibrium mechanics. A partially cracked, mechanically loaded reversible system is considered. A stability criteria is formulated. The equilibrium theory is valid for non-linear load deflection relationships and is applied to linear elastic fracture mechanics.

56905 Interaction solid solution hardening in 2.25Cr-1Mo steel. Klueh, R.L. (Oak Ridge National Lab., TN). *Mater. Sci. Eng.;* **35**: 239-253(1978).

The creep behavior of annealed 2.25Cr-1Mo steel - a low-alloy ferritic steel - is complicated by the metallurgical processes that occur in the steel. These processes, which involve both solid solution and precipitation effects, give rise to creep curves that differ from a classical three-stage creep curve in that two steady-state stages occur. During the first steady-state stage, the creep rate is controlled by the motion of dislocations that contain atmospheres of carbon and molybdenum atom clusters, a process termed interaction solid solution hardening. Eventually, the precipitation of Mo_2C removes molybdenum and carbon from solution, and the creep rate increases to a new steady state where the creep rate is controlled by atmosphere-free dislocations moving through a precipitate field. These nonclassical curves occur at intermediate stresses. As the stress decreases, the first steady-state stage disappears because the dislocation velocity decreases and the molybdenum-carbon atmosphere will be able to diffuse with the dislocation. At high stresses a classical curve occurs when the creep rate is controlled by a combination of processes that operate in the two steady-state stages of the nonclassical curves.

56906 Low cycle fatigue of steels for nuclear pressure vessels in hot water. Garnier, C.; Kowalczuk, G.; Barrachin, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). pp L8/8 1-9 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Low cycle fatigue analysis is a very important problem in structural mechanics, especially for nuclear pressure vessels. A general program on low cycle fatigue in hot water is in progress at Saclay in order to assess the conservatism of design fatigue curves. In order to keep control of water chemistry, the test rig is connected with the PRIMEAU loop and therefore a constant flow of water is obtained through the specimens. Tested samples are small strips of rectangular cross section (2x10x61 mm). They are loaded in circular bending with controlled deflection. Practically they are placed between four supports, two moving and two fixed. The water temperature is kept near 265°C while the oxygen abd hydrogen contents and the pH are monitored. A frequency as low as 0.1 cpm has been chosen in order to take into account time effects. Calibration tests in air at room temperature are also made with the same type of device. Tests are now in progress in austenitic alloys and the available results are given. Tests on a ferritic steel have been completed.

56907 Review of time-dependent fatigue behavior of structural alloys. Greenstreet, W.L. (Oak Ridge National Lab., TN (USA)). pp L9/1 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56908 Constitutive theory for metal creep. Laflen, J.H. (General Electric Co., Evendale OH (USA)); Stouffer, D.C. (Cincinnati Univ., OH (USA)). pp L1/4 1-10 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The objective of this research has been to establish a constitutive theory for the elevated temperature behavior of metals capable of predicting the inelastic strain response for an arbitrary stress history. To determine the phenomenological description of a specific material, a series of load rate, strain rate, and creep tests were performed on wrought Udimet 700 at 1700°F. The analysis of the data showed the quasi-static creep strain rate response was bounded from above and below. The upper bound corresponded to the locus of maximum primary creep rates, and was observed in the higher of the quasi-static load tests. The lower bound was the minimum creep rate, and was observed in the creep tests, strain rate tests, and at the low load rate tests. Since the maximum primary creep rate was the same for high loading rates and the minimum creep rate was a function of stress, the creep curve was found to be time-translation invariant in these cases. The concept of transition from one creep rate to another was shown to depend on a material stress rate coordinate which was derived from the concept of a thermally activated process time which was stress dependent. The experimental evidence of this paper has demonstrated the shortcomings of the classical approaches to metal creep. Based on a phenomenological approach, a new single integral constitutive theory was developed which is consistent with the observed experimental results. This theory is capable of predicting most phenomenological aspects of metal creep.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 56510, 56711, 57374, 57375

56909 (ISM—218) Heisenberg exchange in dilute heavy rare earth alloys. Legvold, S.; Queen, J.H.; Beaudry, B.J.; Harmon, B.N. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 10p. (CONF-790909—9). Dep. NTIS, PC A02/MF A01.

From International conference on magnetism; Munich, F.R. Germany (Sep 1979).

Residual resistivities of one atomic percent heavy rare earths Gd to Er dissolved in thorium have shown a strong dependence on solute atomic volume. When similar resistivity measurements of Mackintosh and Schmidt for Gd to Er dissolved in Lu were adjusted for the atomic volume effect they showed $S(S + 1)$ dependence.

56910 Electronic structure of a Ti(0001) film. Feibelman, P.J.; Appelbaum, J.A.; Hamann, D.R. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B: Condens. Matter;* **20**: No. 4, 1433-1443(15 Aug 1979).

A self-consistent calculation of the electronic structure of a thin Ti (0001) film leads to the prediction of a band of surface states coincident with the Fermi level and extending a few tenths of a eV on either side of it. The calculation is performed in a linear combination of Gaussian orbitals basis. The procedure by which the evaluation of the Hamiltonian matrix is reduced to summing over three-center integrals as well as the method by which Gaussian bases are selected are thoroughly described. Observation of the predicted surface band by angle-resolved photoemission is discussed, as well as the question of how general a surface band near the Fermi energy should be among the hcp d-band metals. A shift of surface atom core levels to 0.25-eV greater binding energy is predicted, and the origin of this shift is discussed.

56911 High-frequency vibrational modes at stepped Pt(111) surfaces. Mostoller, M.; Landman, U. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **20**: No. 4, 1755-1757(15 Aug 1979).

We show that vibrational modes with frequencies above the maximum in the bulk can occur at the steps of the Pt(332) or 6(111) x (111) surface, as observed by Ibach and Bruchmann, if the largest force constants are increased by ~30—40 percent at the steps. The calculations are done by applying the recursion method within clusters of thousands of atoms, with a rotationally invariant first- and second-neighbor bond-angle model for the interatomic forces.

56912 Modulated structures in inorganic one-dimensional metals. Williams, J.M.; Schultz, A.J. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 187-192(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

We discuss the formation and nature of modulated structures in 1-dimensional inorganic metals.

56913 Transport properties of the compositionally modulation alloy Cu/Ni. Schuller, I.; Falco, C.M.; Hilliard, J.; Ketterson, J.; Thaler, B.; Lacoe, R.; Dee, R. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 417-421(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

We report preliminary transport measurements; electrical resistivity, thermopower, Hall effect and mangetoresistance, of a number of Cu/Ni composition modulated alloy films over the temperature range 10—300 °K and for magnetic field up to 70 kGauss.The results indicate non-monotonic dependence of the transport properties on the modulation amplitude. The Hall coefficient saturates around 40 kGauss in contrast to the transverse magnetoresistance which does not show evidence for saturation up to 70 kGauss.

56914 McMillan-Rowell tunneling spectroscopy in the Nb-Zr system. Wolf, E.L.; Noer, R.J. (Ames Lab., IA (USA)). *Solid State Commun.;* **30**: No. 6, 391-393(May 1979).

A report is presented on the first full application of tunneling spectroscopy to a superconducting transition metal alloy: Nbsub(1-x)Zrsub(x) at x = 0.25, corresponding to the maximum Tsub(c) in the Nb-Zr system. The spectral function $\alpha^2F(\omega)$ and related parameters, when compared to those for the Nb, confirm that the increase in Tsub(c) from 9.22°K (x = 0) to 10.8 K (x = 0.25) arises largely by softening of the effective phonon spectrum.

56915 Superconductivity in the tungsten bronzes. Ostenson, J.E.; Shanks, H.R.; Finnemore, D.K. (Ames Lab., IA (USA)). *J. Less-Common Met.;* **62**: 149-153(Nov-Dec 1978).

Four superconducting alkali tungsten bronzes (M_xWO_3) have been studied at pressures up to 20 kbar in a search for pressure-induced phase changes. Both the Na and the Rb bronzes show a linear dependence of Tsub(c) on pressure with no evidence of a phase change. In contrast, the K and Li bronzes show a distinct change in slope at 4.5 and 8.0 kbar, respectively, which may indicate some sort of transition. A series of rare earth tungsten bronzes has been surveyed to look for materials which might show the coexistence of superconductivity and long-range magnetic order. In these initial attempts, all the rare earth bronzes had cubic crystal structures and none showed superconductivity. The only phase change found was a sharp magnetic ordering transition at 1.54 K in a Tb bronze.

56916 New approach to transition metal tunnelling. Wolf, E.L.; Zasadzinski, J. (Ames Lab., IA (USA)). pp 666-670 of Transition metals, 1977. Lee, M.J.G.; Perz, J.M.; Fawcett, E. (eds.). Bristol; Institute of Physics (1978).

From International conference on physics of transition metals; Toronto, Canada (15 Aug 1977).

Tunnel junctions on transition metal superconductors S are formed by deposition (10^{-9} Torr) on an outgassed S foil of 30 to 70 A of Al, subsequently oxidised to form In/Al_2O_3/S and In/Al_2O_3/A6S junctions. Clear S phonon structure indicates a high junction quality and permits, in the former case, direct determination of $\alpha^2F(\omega)$ and lambda.

56917 Mechanical equation of state analysis of elevated temperature cyclic deformation of austenitic stainless steels. Rohde, R.W.; Swearengen, J.C. (Sandia Labs., Albuquerque, NM (USA)). pp L8/5 1-10 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A mechanical equation of state is a functional relationship among appropriate state variables such that mechanical response can be predicted solely on the basis of current values of the state variables. Recent consensus requires that state relations incorporate at least one state variable whose value is controlled by some aggregate characteristic of the state of the microstructure. This concept has great potential value since, if such a relationship exists and if the state variables can be determined, the mechanical response of a structure may be predicted without knowledge of its history. The load-relaxation experiment is commonly utilized to characterize the rate-dependent plastic behavior of a metal and thereby evaluate the potential for description in terms of an equation of state. Relaxation is usually assumed to progress while the microstructure remains constant because the plastic strain accrued is small. However, at high temperatures the assumption may be falacious since thermally induced microstructural recovery may occur. The present work considers load relaxation data reported by Conway, Stentz and Berling, for 304 and 316 stainless steels during cyclic deformation with various hold times. The experiments were conducted at 650 and 538°C, temperatures sufficiently high so that recovery is likely to occur during the experiment. The experimental data are analyzed to determine if a power law suggested as a equation of state can represent the observed behavior.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 55954, 55958, 56112, 56164, 56173, 56174, 56175, 56176, 56188, 56189, 56877, 56900

56918 (COO—2576-9) **Elastic and plastic strains and the stress corrosion cracking of austenitic stainless steels. Final report.** Vaccaro, F.P.; Hehemann, R.F.; Troiano, A.R. (Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Metallurgy and Materials Science). Aug 1979. Contract EY-76-S-02-2576. 133p. Dep. NTIS, PC A07/MF A01.

The influence of elastic (stress) and plastic (cold work) strains on the stress corrosion cracking of a transformable austenitic stainless steel was studied in several aqueous chloride environments. Initial polarization behavior was active for all deformation conditions as well as for the annealed state. Visual observation, potential-time, and current-time curves indicated the development of a pseudo-passive (flawed) film leading to localized corrosion, occluded cells and SCC. SCC did not initiate during active corrosion regardless of the state of strain unless severe low temperature deformation produced a high percentage of martensite. Both elastic and plastic deformation increased the sensitivity to SCC when examined on the basis of percent yield strength. The corrosion potential, the critical cracking potential, and the potential at which the current changes from anodic to cathodic were essentially unaffected by deformation. It is apparent that the basic electrochemical parameters are independent of the bulk properties of the alloy and totally controlled by surface phenomena.

56919 Computer simulation of the formation of "tweed" and modulated structures in decomposition reactions. Chen, S.; Morris, J.W. Jr.; Khachaturyan, A.G. (Department of Materials Science and Mineral Engineering and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 168-172(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

A model of coarsening in a heterogeneous cubic alloy with cubic or tetragonal precipitates is proposed. According to the model the coarsening is controlled by the relaxation of the elastic strain energy. The computer simulation of coarsening demonstrates good agreement with electron microscopic observation of the structure and diffraction pattern.

56920 Assessment of oxygen diffusion during UO_2-zircaloy interaction. Cronenberg, A.W.; El-Genk, M.S. (EG and G Idaho, Inc., Idaho Falls (USA)). *J. Nucl. Mater.;* **78**: No. 2, 390-407(Dec 1978).

During high-temperature transients on zircaloy clad nuclear fuel rods, both external and internal cladding oxidation have been observed. The result of these oxidation processes is to embrittle the cladding, making it susceptible to brittle fracture. External oxidation reaction processes are relatively well understood, while the internal processes have received little attention. This paper examines the internal oxidation process which occurs as a result of oxygen transport from the UO_2 fuel pellets to the zircaloy cladding. An oxygen diffusion model has been derived which solves a coupled two-media problem with a moving boundary in zircaloy due to alpha-beta phase change. Analytical results for the time and temperature dependence of such zircaloy oxidation were found to compare favorably with both in- and out-of-pile experimental data.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56398, 56435, 56462, 56484, 56486, 56492, 56508, 56528, 56531, 56543, 56594, 56712

56921 Irradiation enhanced diffusion and irradiation creep tests in stainless steel alloys. Loelgen, R.H.; Cundy, M.R. (Commission of the European Communities, Petten (Netherlands). Joint Nuclear Research Center); Schuele, W. (Commission of the European Com-

munities, Ispra (Italy). Joint Research Centre). pp L8/11 1-15 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A review is given of investigations on the rate of phase changes during neutron and electron irradiation in many different fcc alloys showing either precipitation or ordering. The diffusion rate was determined as a function of the irradiation flux, the irradiation temperature and the irradiation dose. It was found that the radiation enhanced diffusion in all the investigated alloys is nearly temperature independent and linearly dependent on the flux. From these results conclusions were drawn concerning the properties of point defects and diffusion mechanisms rate determining during irradiation, which appears to be of a common nature for fcc alloys having a similar structure to those investigated. It has been recognized that the same dependencies which are found for the diffusion rate were also observed for the irradiation creep rate in stainless steels, as reported in literature. On the basis of this obervation a combination of measurements is suggested, of radiation enhanced diffusion and radiation enhanced creep in stainless steel alloys. Measurements of radiation enhanced diffusion are less time consuming and expensive than irradiation creep tests and information on this property can be obtained rather quickly, prior to the selection of stainless steel alloys for creep tests. In order to investigate irradiation creep on many samples at a time two special rigs were developed which are distinguished only by the mode of stress applied to the steel specimens. Finally, a few uniaxial tensile creep tests will be performed in fully instrumented rigs.

56922 (HEDL-TME—79-19) **Ductility and strength of FFTF/CRBRP structural materials irradiated in various spectra. Second interim report.** Ward, A.L.; Blackburn, L.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1979. Contract EY-76-C-14-2170. 55p. AT.

Experimental description of the fluence and spectrum dependence of strength and ductility in 304SS, 316SS, weld-deposited 308L SS and Alloy 718 irradiated at low temperatures (644 to 699K) was extended to a total fluence of 3.7×10^{26} n/m^2. Tension test results for the stainless steel materials from the FFTF/CRBRP Structural Materials Irradiation Experiment continued to verify earlier indications of significant spectral effects. Application of simple scaling procedures yielded relative damage cross sections which were found to incorporate separable spectrum and temperature dependencies. When normalized to a single temperature (658K) and multiplied by the total fluence, the cross sections provide an excellent correlation parameter for the irradiation damage. Energy-dependent fluence limits for 10% total elongation in the stainless steel materials were determined using the spectral and temperature dependencies of this study coupled with data variability evaluated in a larger data base. Irradiation effects in Alloy 718 were small relative to those observed in the stainless steels and spectral effects could not be defined quantitatively in detail. Estimates of fluence limits for 10% total elongation were determined for moderately soft spectra.

56923 (HEDL-TME—79-21) **Strength and ductility of fast reactor irradiated austenitic stainless steels.** Blackburn, L.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1979. Contract EY-76-C-14-2170. 38p. Dep. NTIS, PC A03/MF A01.

Strength, ductility and flow stress properties of 304 SS, 316 SS and 308 SS weld deposits were correlated with a neutron irradiation damage parameter that incorporates effects of temperature, exposure and spectrum. Trend curves for nominal and minimum property values provide descriptions of irradiation effects for use in engineering applications.

56924 (INIS-mf—4470, pp vp) **Development of criteria for the failure of zircaloy fuel cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56925 Computer simulation of replacement sequences in copper. Schiffgens, J.O. (Hanford Engineering Development Lab., Richland, WA (USA)); Schwartz, D.W.; Ariyasu, R.G.; Cascadden, S.E. *Radiat. Eff.;* **39**: No. 3-4, 221-231(Dec 1978).

Results of computer simulations of <100>, <110>, and <111> replacement sequences in copper are presented, including displacement thresholds, focusing energies, energy losses per replacement, and replacement sequence lengths. These parameters are tabulated for six interatomic potentials and shown to vary in a systematic way with potential stiffness and range. Comparisons of results from calculations made with ADDES, a quasi-dynamical code, and COMENT, a dynamical code, show excellent agreement, demonstrating that the former can be calibrated and used satisfactorily in the analysis of low energy displacement cascades. Upper limits on <100>, <110>, and <111> replacement sequences were found to be approximately 10, approximately 30, and approximately 14 replacements, respectively.

56926 Effects of neutron irradiation on the superconducting properties of Nb_3Pt. Moehlecke, S.; Cox, D.E. (Brookhaven National Lab., Upton, NY (USA)); Sweedler, A.R. (California State Univ., Fullerton (USA)). *J. Less-Common Met.;* **62**: 111-118(Nov-Dec 1978).

The effects of high energy (E > 1 MeV) neutron irradiation on the superconducting transition temperature Tsub(c), the lattice parameter a_0, and the degree of long range order S, for Nb-Pt alloys of A15 type are described. The Tsub(c) (midpoint) of stoichiometric Nb_3Pt is depressed from 10.6 K to 3.5 K after irradiation to a fluence of 1.44×10^{19} n cm^{-2}, and there is an accompanying decrease in S, from 0.95 to 0.59 and an increase in a_0 of 0.13%. Isochronal annealing data for different compositions are also presented. The results are discussed in terms of site-exchange disorder, and a correlation between radiation and thermally induced disorder is noted.

56927 Scattering of X-rays in irradiated A15 compounds. Pande, C.S.; Viswanathan, R. (Brookhaven National Lab., Upton, NY (USA)). *J. Less-Common Met.;* **62**: 119-126(Nov-Dec 1978).

Previous transmission electron microscope studies of neutron-irradiated Nb_3Sn showed that the irradiation primarily produced small coherent disordered regions in a much less disordered matrix. The present authors examine the X-ray scattering for such a system within the framework of the kinematic theory of X-ray diffraction. It is shown that the following X-ray observations in irradiated A15 compounds are consistent with the electron microscope observations: (a) uniform lattice expansion; (b) no significant change in X-ray line widths; and (c) a weakening of both fundamental and superlattice line intensities on irradiation.

56928 Chemical effects on secondary photon and ion emission of ion bombarded beryllium, carbon and boron carbide surfaces. Wright, R.B.; Lui, M.B.; Gruen, D.M. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **76**: No. 77, 05-207(Sep-Oct 1978).

Beryllium metal has been proposed as a low-Z material for a first-wall coating or a liner in tokamak reactor vacuum vessel applications. In this connection the effects of ion bombardment on the impurity release and erosion properties of beryllium need to be ascertained. The present work has focused on the effects of hydrogen and deuterium bombardment on the secondary photon and secondary ion emission properties of beryllium. The most significant finding is that both the photon and ion emission are strongly enhanced as a result of hydrogen and deuterium bombardment. This finding is of potential importance to impurity control and transport problems associated with fusion reactor applications of beryllium, and seems to be the first reported instance of secondary photon enhancement due to H^+ or D^+ bombardment. The secondary photon emission from beryllium was measured as a function of incident ion energy from 200 eV to 15 keV and for current densities varying from 10 to 800 μA/cm^2 for Kr^+, Ar^+, Ne^+, He^+, O^+_2, N^+_2, D^+_2 and H^+_2.

56929 Transmission electron microscopy observation of interstitial clusters in neutron-irradiated niobium. Chen, C.W.; Chang, C.P. (Ames Lab., IA (USA)); Elen, J.D.; Mastenbroek, A. *Radiat. Eff.;* **38**: No. 3-4, 211-220(Sep 1978).

Irradiation of moderately pure niobium with fast neutrons to a fluence of 8×10^{19} n/cm^2 (E > 0.1 MeV) at 80°C was shown to produce large defect clusters (LDC) of interstitia in a previous paper. The present report deals with the geometry and dislocation characteristics of the LDC analyzed by TEM techniques. Experimental procedures are described for the determination of the habit plane and the Burgers vector of the LDC under the circumstances that the subclusters inside the LDC cannot be resolved under dynamical imaging conditions. The LDC display an overall habit plane of brace 111 brace, and their Burgers vectors probably involve more than one a/2<111> or one a/2<110>. Evidence is presented to indicate that the LDC are neither fully-developed rafts nor defect complexes of impurity atoms. A model is proposed for the LDC, and a formation mechanism is suggested.

56930 Effects of irradiation on thermomechanical behaviour of inelastic materials. Perzyna, P. (Polska Akademia Nauk, Warsaw). pp L1-11 1-15 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The objective of the paper is to give a critical review of phenomenological descriptions of thermomechanical behaviour of irradiated, inelastic materials. In the first part an analysis of neutron irradiation effects is presented. This analysis is based on available experimental results for inelastic materials. Particular attention is also given to the discussion of the mechanisms responsible for internal dissipation of an irradiated material. On the basis of these dissipative mechanisms the irradiation effects are explained and simple models are proposed. These models are used in the second part of the paper to formulate reasonable phenomenological theories of thermoinelasticity of irradiated materials. The third part of this

paper is devoted to the explanation of fracture phenomena in irradiated metals. The fourth part considers the thermo-radiation-mechanical coupling.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 55939

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 56073, 56074, 56075, 56076, 56468, 56733

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 56418, 56938, 56946

56931 Modulated structure in metal carbide systems of V_2C, Nb_2C and Ta_2C. Hiraga, K.; Hirabayashi, M. (The Research Institute for Iron, Steel and Other metals, Tohoku University, Sendai 980, Japan). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 276-278(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Two modulated structures of (V/sub 1-x/Nb/sub x/)$_2$X and (Nd/sub 1-x/$_2$C have been studied by high voltage, high resolution electron microscopy. These structures consist of periodic antiphase domains based on the structures of V_2C and Ta_2C. The lattice images reveal fluctuations in the periods of antiphase boundaries.

56932 Lattice shear distortions in fluorite structure oxides. Faber, J. Jr.; Mueller, M.H.; Hitterman, R.L. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 376-378(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Crystallographic shear distortions have been observed in fluorite structure, single crystals of UO_2 And Zr(Ca)O/sub 2-x/ by neutron-diffraction techniques. These distortions localize on the oxygen sublattice and do not require the presence of an external strain. The internal rearrangement mode in UO_2 is a transverse, zone boundary q=2π/a (0.5, 0,0) deformation with amplitude 0.014 A. In Zr(Ca)O/sub 2-x/, the mode is a longitudinal, q=2π/a (0,0,0.5) deformation with amplitude 0.23 A. Cation-anion elastic interaction dominate in selecting the nature of the internal distortion.

56933 Deuteron density modulation of D atoms in PdD/sub 1-x/. Mueller, M.H.; Brun, T.O.; Hitterman, R.L.; Knott, H.W.; Satterhwaite, C.B.; Ellis, T.E. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 391-393(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Recent resistivity and neutron diffraction measurements have provided evidence for ordering of D(H) atons on the octahedral interstitial sites of PdD/sub 1-x/. This order-disorder transition is responsible for the "50 K anomaly" which has been reported in many of the physical properties. Neutron diffraction measurements on a PdD/sub 0.76/ single crystal revealed satellite reflection at (4/5,2/5,0) and equivalent positions. These satellites can be accounted for by a multi-domained tetragonal unit cell with a/sub t/=a/sub c/ $\sqrt{5}$/2 and c/sub t/=c/sub a/. This ordered state can be described as a deuteron density wave along a <420> cubic direction. This density is modulated such that four fully occupied planes (Pd D) are followed by a vacant plane (Pd only).

56934 Modulated ordering Nb-H alloys. Kajitani, T.; Brun, T.O.; Mueller, M.H.; Birnbaum, H.K.; Makenas, B.J. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 394-396(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Ordering reactions in α' and β-NbH alloys have been investigated using elastic theory. The α'-β and β-λ phase transformations are driven by the elastic ineraction in the niobium lattice distorted by the protons on the t-site interstitials. The β phase is shown to have a three dimensional structure. The fundamental period of the long range modulation along the c-axis in the λ-phase, an incommensurated β phase, is approximately 5 lattice constants.

56935 Structure of the λ-phase of niobium-deuterium. Brun, T.O.; Kajitani, T.; Muller, M.H.; Westlake, D.G.; Makenas, B.J.; Birnbaum, H.K. (Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 397-399(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Lambda phases of NbD/sub x/ (0.78< or =x< or =0.84), which exist below 220 K, have been studied by neutron and electron diffraction. The observed modulated structure can be described as a deuteron concentration wave in a slightly distorted bcc Nb matrix. The wave-vector is parallel to <001>, and the wavelength varies from 16.0 A to 21.4 A, increasing with increasing concentration.

56936 Long-range order and the β-β' transition in single crystal V_2H via X-ray scattering. Jo, H.S.U.; Moss, S.C.; Westlake, D.G. (Physics Department, University of Houston, Houston, Texas 77004). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 403-405(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

In contrast to V_2D, V_2H exhibits two phase transitions, from ordered monoclinic β to disordered tetragonal β' and from β' to disordered bcc α. In the transition β-β' the hydrogens presemably remain in one set of octaheiral sites but disorder within this set. The induced vanadium atom modulation thereby disappears although the tetragonal structure remains. Using the metal-atom (1/2, 0, 1/2) modulation the long-range order is studied with X-rays as a function of temperatures and is shown to diminish continuously in a second-order fashion up to T/sub c/=168 °C. Strong short range order diffuse intensity has been observed in the β'-phase.

56937 Quantitative phase analysis of uranium-plutonium mixed oxide and carbide by X-ray diffractometry. Ganguly, C. (Bhabha Atomic Research Centre, Bombay (India). Radiometallurgy Section). pp 486-499 of Phase transformations and phase equilibria. Bombay, India; Department of Atomic Energy (1977).

From Symposium on phase transformations and phase equilibria; Bangalore, India (16 Oct 1975).

Quantitative phase analysis is an important aspect of the quality control of uranium-plutonium mixed oxide and carbide fuels for fast reactors. It has been described how the sintered pellet of uranium-plutonium mixed oxide, consisting of a mixture of solid solutions with varying uranium and plutonium concentrations, is analysed quantitatively for individual mixed crystal fractions. Assuming that the line profile of a pure crystal can be either Gaussian, Cauchy, Error or Arc tangent function, the X-ray diffraction pattern of a mixed oxide pellet is analysed by regression analysis to determine the individual mixed crystal fraction. An absolute method for the quantitative phase analysis of mono-, di- and sesquicarbide and dioxide in the U-Pu-C-O system by X-ray diffraction has been described. Theoretically, the integrated intensity for the different selected lattice planes of the above phases are calculated taking into consideration the crystal structure, Lorentz polarisation factor, multiplicity factor, temperature factor, absorption factor and unit cell volume. For the pure uranium mono-, di-, sesquicarbide and dioxide the calculated intensity ratios between different planes were found comparable with the corresponding measured integrated intensity ratios, thus confirming the basis of calculation. Using these calculated values and experimentally determining the corresponding integrated intensities of the X-ray diffraction pattern any carbide pellet of U, Pu or 'U-Pu' can be quantitatively analysed directly for mono-, di-, sesquicarbide and oxide phases.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 56434, 56733, 56943

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 56539, 56733, 57380

56938 (CONF-790761—1) **High-temperature thermodynamic properties of the thorium-oxygen system.** Ackermann, R.J.; Tetenbaum, M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 25p. Dep. NTIS, PC A02/MF A01.

From International colloquium on materials for high-temperature energy; Toronto, Canada (16 Jul 1979).

Thermodynamic properties of the Th-O system at high temperatures were investigated by means of mass effusion, mass spectrometric, and transpiration techniques over compositions ranging from the congruently vaporizing composition to the lower phase boundary composition. A very sharp decrease in O potential occurs when stoichiometric thoria is reduced but slightly from the stoichiometric composition. The small extent of reduction over a wide range of O potentials measured in the temperature range 2400 to 2655°K is a clear illustration of the higher stability of the ThO/sub 2-x/ phase compared with actinide oxides such as UO/sub 2-x/, PuO/sub 2-x/, as well as other metal oxide systems. Estimates of ΔH-bar/sub O_2/, ΔS-bar/sub O_2/, and the standard free energy of formation of bivariant ThO/sub 2-x/ compositions were made. A substantial increase in the total pressure of Th-bearing species occurs when stoichiometric thoria is reduced toward the lower phase boundary. The increase in pressure can be attributed primarily to the increasing contribution of the ThO gaseous species. Total pressures of Th-

bearing species above ThO/sub 2-x/ compositions calculated by means of experimental O potentials and the known or estimated free energy of formation values of the gaseous species and condensed phase are in reasonable agreement with experimental values.

56939 (KBS-TR—116) **Leaching of Al_2O_3 in simulated repository conditions.** Svensson, B.M.; Dahl, L. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 15p. (In Swedish). (STUDSVIK-MS—78/213). Dep. NTIS (US Sales Only), PC A03/MF A01.

Al_2O_3 material has been leached at 90 deg C in: simulated ground water at pH 8.5, embedded in bentonite + silica sand saturated with the same water, and in simulated ground water at pH 6 and pH 10. Leaching periods varied from 30 days to 300 days. We observed slight weight increments in all cases from deposits on samples from the environment. These mask weight losses from Al_2O_3 that may have occurred.

56940 (N—79-13160) **Sialons as high temperature insulators.** Phillips, W.M.; Kuo, Y.S. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Dec 1978. Contract NAS7-100. 32p. NTIS PC A03/MF A01.

Sialons were evaluated for application as high temperature electrical insulators in contact with molybdenum and tungsten components in hard vacuum applications. Both D.C. and variable frequency A.C. resistivity data indicate the sialons to have electrical resistivity similar to common oxide in the 1000 C or higher range. Metallographic evaluations indicate good bonding of the type 15R ALN polytype to molybdenum and tungsten. The beta prime or modified silicon nitride phase was unacceptable in terms of vacuum stability. Additives effect on electrical resistivity. Similar resistivity decreases were produced by additions of molybdenum or tungsten to form cermets. The use of hot pressing at 1800 C with ALN, Al_2O_3 and Si_3N_4 starting powders produced a better product than did a combination of SiO_2 and AIN staring powders. It was indicated that sialons will be suitable insulators in the 1600K range in contact with molybdenum or tungsten if they are produced as a pure ceramic and subsequently bonded to the metal components at temperatures in the 1600K range.

56941 (STUDSVIK-K—1/4-78-3) **Measurements of surface enlargements of glass caused by rapid cooling.** Chyssler, J.; Groenroos, B.; Stroem, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1978. 6p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

After heating in air to 600 C, boron silicate glass was rapidly cooled in water, and the surface enlargement studie in a sweeping electron microscope.

56942 **High pressure study of the superconducting and magnetic transitions of Ersub(1-x)Gdsub(x)Rh_4B_4.** Chu, C.W. (Houston Univ., TX (USA). Dept. of Physics); Huang, C.Y.; Kohn, S.; Smith, J.L. (Los Alamos Scientific Lab., NM (USA)). *J. Less-Common Met.;* **62**: 245-250(Nov-Dec 1978).

The superconducting and magnetic transitions were investigated under hydrostatic pressure up to about 19 kbar in the rare-earth rhodium boride ternaries, Ersub(1-x)Gdsub(x)Rh_4B_4, near the critical concentration of Ge above which the superconducting transition is completely suppressed. The superconducting transition temperature remains almost unchanged under pressure for all samples studied. The magnetic ordering temperature is enhanced linearly but at an increased rate as x approaches the critical concentration from below.

56943 **Melting at particle impact sites during erosion of ceramics.** Yust, C.S.; Crouse, R.S. (Oak Ridge National Lab., TN). *Wear;* **51**: 193-196(1978).

A scanning electron microscope was used to study the eroded surfaces of alumina and mullite refractories. The observations give evidence of plastic shear on eroded ceramic surfaces which suggest melting may accompany the deformation. (FS)

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 55930, 56111, 56164, 56822, 56920

56944 (KBS-TR—117) **Leaching of Al_2O_3 in double-destilled water.** Svensson, B.M.; Blomqvist, G. (Kaernbraenslesaekerhet, Stockholm (Sweden)). May 1978. 28p. (In Swedish). (STUDSVIK-MS—78/214). Dep. NTIS (US Sales Only), PC A03/MF A01.

Al_2O_3 material has been leached at 90 deg C in pure double-distilled water and in double-distilled water buffered to pH 9.3 with sodium carbonate. The corrosion rate of Al_2O_3 has been calculated after determination of the Al-content of the leaching solution by atomic absorption spectrometry. The corrosion rate in the pure water was 10.10^{-6} mm.year^{-1} all through the investigation, 184 days hitherto. The corrosion rate in the solution at pH 9.3 was approximately 230.10^{-6} mm.year^{-1} during the first days and then steadily decreasing to $10\text{-}12.10^{-6}$ mm.year^{-1} after 120 days and stabilising there during the leaching period 120 to 184 days. The leached material has been sent to other laboratores for further investigations.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56431, 56435, 56467, 56517, 56627, 56928

56945 **Thermal and in-reactor densification of UO_2: mechanisms and experimental results.** Assmann, H.; Stehle, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Hauptbereich Reaktortechnik). pp C3/1 1-16 of Structural mechanics in reactor technology. Vol. C. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The modelling of fuel behaviour during irradiation and the tailoring of an irradiation stable fuel require an accurate description of the stress free volume changes due to fuel densification and fuel swelling. The influence of fuel flows due to creep and hot pressing should be considered separately. This paper presents detailed densification models which describe the dependence of densification on time or burnup, temperature, density, pore size distribution, grain size, and fission rate. UO_2 matrix swelling due to fission product accumulation and densification due to pore shrinkage are considered to operate simultaneously and are linearly superposed. Four temperature regions can be identified which describe the dependence of irradiation induced fuel densification on temperature. The shrinkage rate of small pores strongly controls the initial densification rate. Experimental verification of the densification models is obtained from numerous constant temperature thermal sinter tests conducted between 1200°C and 1900°C as well as in isothermal irradiation tests between 1000°C and 1200°C and around 700°C. Although the kinetics of thermal and in-reactor densification are different, standarized thermal resinter tests can be established and used to predict the in-reactor densification.

56946 **Stress-induced optical dichroism of V^--centers in MgO.** Modine, F.A. (Oak Ridge National Lab., TN (USA)). *J. Phys. Chem. Solids;* **40**: No. 4, 305-309(1979).

The stress-induced optical dichroism and optical spectra of the V^--centers in electron irradiated MgO are reported. The dichroism spectrum can be largely attributed to a paraelastic alignment of inherently-dichroic V^--centers. A curve-fit analysis of the lower-energy portions of the dichroism and absorption spectra yields the ratio of the transition dipole strengths, D(parallel)/D(perpendicular) = 1.55 +- 0.2, and the energy splitting, E(parallel)/E(perpendicular) = 0.22 +- 0.07 eV, for light polarized parallel and perpendicular to the defect symmetry axis. The spectra also have considerable intensity in their high-energy tails, and it is speculated that a portion of this intensity is due to the V-center. The implications of the results with regard to the electronic structure of the center are discussed.

COMPOSITE MATERIALS

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 56405, 56406, 56453, 56572, 56716, 56723

56947 **Tests on failure mechanism of thick prestressed concrete rings with inside pressure.** Stoeckl, S.; Neuner, J.; Grasser, E. (Technische Univ. Muenchen (Germany, F.R.)). pp H4/8 1-11 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Within a German PRCV-program at the Institut fuer Massivbau of the Technical University of Munich tests are made in order to provide the information necessary for an analytical modelling of thick concrete cylinders. In 1976 the series was started with 2 tests on large size unreinforced concrete rings (inner diameter 10.9 cm, outer diameter 36.5 cm resp. 62.5 cm, thickness 10 cm) under inside pressure. The loading was electronically controlled under the condition of a linear increase of the mean strain rate (0.0002/hour). This method provides detailed information on the deformation behavior during rupture of the specimen. The main strain was measured at the inner side of the ring by 8 inductive gages. To obtain the information necessary for a finite element analysis the specimen was subdivided by a triangular net for which all tangential strains have been measured by inductive gages, whereas all radial and diagonal strains have been measured using strain gages. Additionally the increase of the ring diameter has been recorded.

56948 Non-linear dynamic relaxation and its application to pressure vessel problems. Welch, A.K.; Storer, G. (Taylor Woodrow Construction Ltd., Southall (UK)). pp H2/3 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

56949 Limit-analysis of thick axi-symmetric vessels. Zavelani Rossi, A.; Binda, L. (Politecnico di Milano (Italy)). pp H3/5 1-11 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In nuclear plant technology multiple load conditions must be taken into account including catastrophic events. When such extreme load conditions are considered a design based on purely elastic analysis turns out to be too much conservative. When ductility of the material is assessed, recourse to limit analysis is recommended, provided that changes in geometry at collapse do not significantly affect the stress distribution. When material characteristics do not correspond to theoretical assumptions of perfectly plastic behaviour, limit analysis can still contribute, when compared with experimental results, to a better understanding of structure reliability. A method for limit analysis at plane and axi-symmetric problems has been recently proposed by the same authors. It is based on a finite element modeling of the stress yield through adoption of one (plane problems) or two (axi-symmetric problems) stress functions. The present contribution is intended to show some significant results obtained in the solution of axi-symmetric problem and to discuss some aspects which are susceptible to improve the numerical efficiency of the solution phase.

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 56222, 56235, 56236, 56237, 56238

56950 (BM-RI—8362) **Centrifugal casting of refractory concretes.** Marchewka, T.L.; Heystek, H. (Bureau of Mines, Tuscaloosa, AL (USA). Tuscaloosa Metallurgy Research Lab.). 1979. 23p. Bureau of Mines, Washington, DC.

Refractory pipe liners are required when extremely hot gases or abrasive solids are transported between processing units in coal gasification plants. One promising technique for producing refractory pipe (or refractory pipe liners) is centrifugal casting. For this study, the effect of processing variables such as workability, additives, reinforcement and spinning time, and centrifugal force were evaluated using four commercial refractory concretes. In addition, data on characteristics such as strength, density, abrasion, and spalling resistance of 5-inch-diam refractory pipe were developed. Techniques for forming large-diameter (19-inch) refractory pipe also were evaluated.

56951 (KBS-TR—84) **Fabrication and handling of bentonite blocks.** (Kaernbraenslesaekerhet, Stockholm (Sweden)). Jun 1978. 95p. (In Swedish). Dep. NTIS (US Sales Only), PC A06/MF A01.

In accordance with the project for the final storage of spent nuclear fuel, the waste will be encapsulated into copper canisters, which will be deposited in a final repository located in rock 500 m below ground level. The canisters will be placed in vertical holes in the bottoms of the tunnels, where the copper cylinders will be surrounded by blocks of highly compacted bentonite. When the blocks are saturated with water and expansion is essentially retained as in the actual case, a very high swelling pressure will arise. The bentonite will be extremely impermeable and thus it will form a barrier against transport of corrosive matters to the canister. The blocks are fabricated by means of cold isostatic pressing of bentonite powder. The base material in the form of powder is enclosed in flexible forms, which are introduced into pressure vessels where the forms are surrounded by oil or water. Thus the powder is compacted into rigid bodies with a bulk density of about 2.2 t/m^3 for "air dry" bentonite, which might be compared with a specific density of about 2.7 t/m^3. The placing of a canister is preceded by piling up bentonite blocks to a level just below the canister lid position, after which the slot around the blocks is filled with bentonite powder. The rest of the blocks are mounted after filling bentonite powder into the inner slot around the canister as well. Finally the storage tunnels will be sealed by filling them with a mixture o02067NRM 0000181 45

56952 (SAN—1846-T3) **Amorphous silicon thin film heterojunction solar cells. Third quarterly progress report, 1 April 1979-30 Jun 1979.** (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 1 Aug 1979. Contract ET-78-C-03-1846. 27p. Dep. NTIS, PC A03/MF A01.

Results of experiments on the substitution of carbon for silicon and the substitution of germanium for silicon in hydrogenated a-silicon films grown by capacitive glow discharge techniques are described. Measured optical and electrical properties of the various films are reported. The results are qualitatively consistent with the published data for the hydrogenated a-Si/sub x/C/sub 1-x/ and a-Si/sub x/Ge/sub 1-x/ systems. An appendix on the calculation of optical constants (near the absorption edge) in amorphous films is included. (WHK)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 56958, 56960, 57273, 57274

56953 Characterization of intercalation compounds by electron inelastic scattering analysis. Laval, J.Y; Westmacott, K.H. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 72-74(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

The typical features of electron inelastic scattering in graphite are considered at varying voltages (75 kV to 650 kV). It is shown how the analysis of the diffuse ring patterns, of the relative intensity of the Kikuchi pair and the splitting of the Kikuchi band give precise information (1) on the ordering of the adduct (2) on the intraplanar geometry of intercalation and on the stage of intercalation.

PROPERTIES

REFER ALSO TO CITATION(S) 56107, 56120, 56236, 56237, 56238, 56432, 56436, 56443, 56446, 56447, 56452, 56628, 56941, 56943, 56952

56954 (ISM—224) **Electrical resistivity of (Nd/sub x/Gd/sub 1-x/)/sub 3-y/S_4: magnetic effects.** Taher, S.M.A.; Schwartz, S.; Ho, J.C.; Gruber, J.B.; Gschneidner, K.A. Jr. (Wichita State Univ., KS (USA); North Dakota State Univ., Fargo (USA); Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 2p. (CONF-790641—9). Dep. NTIS, PC A02/MF A01.

From Rare earth research conference; Fargo, ND, USA (25 Jun 1979).

The electrical resistivity rho of single crystal (Nd/sub x/Gd/sub 1-x/)/sub 3-y/S_4 where ($0 \leqq x \leqq 1$, $0 < y < 0.33$) between 2 and 300 K is reported. X-ray diffraction analyses reveal that all samples possess the high temperature γ-phase structure which is represented as the bcc Th_3P_4 defect structure. The electrical resistivity was measured by a four point dc-technique with pressure contacts at the gold-coated bars of samples with dimensions of 1 x 2 x 8 mm. The measured resistivity values without and with a magnetic field of 7.7 kG as a function of 1/T are shown. The resistivity in each sample decreases linearly with decreasing temperature and goes through a minimum as the Curie temperature is reached. The variations in rho/sub min/ and temperatures of rho/sub min/ are attributed to different rare earth concentrations as well as the total metal to sulfur ratios in the samples. Application of a magnetic field reduces the resistivity below about 60 K in all samples. The rho vs T curves for all samples strongly suggest that the increase in resistivity is directly related to the state of magnetic ordering through temperature or applied magnetic field. Since the carrier concentration is greater than 8 x 10^{19}/cm^3 in all samples, the model of Cutler and Mott suggests that E/sub F/ (Fermi energy) lies near but above E/sub c/ (conduction band energy).

56955 (KBS-TR—72) **Thermal conductivity tests on highly compacted bentonite.** Knutsson, S. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Nov 1977. 29p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Three tests were run at constant water content but at different mean temperature. No time dependence was found for the thermal conductivity, which implies that no water transportation was caused by the temperature gradient. A slight increase of the conductivity with increasing temperature was found, the maximum value being 0.78 W/m, K for 73 deg C. The stable water distribution is due to the strong bonds between water molecules and mineral surfaces when the water content is as low as 11 %. Complete water saturation corresponds to a water content of 16.5% which still is a very low value indicating that the degree of water fixation is high also in this state. This means that practically no water movement will take place when the mass is saturated. Consequently the mass will have a thermal conductivity which can be estimated at 0.9-1.3 W/m, K.

56956 Studies of molecular association in H_2O and D_2O vapors by measurement of thermal conductivity. Curtiss, L.A.; Frurip, D.J.; Blander, M. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **71**: No. 6, 2703-2711(15 Sep 1979).

The thermal conductivities of H_2O and D_2O vapors were measured in a modified thick hot wire cell between 358 and 386 K at pressures ranging from 100 to 1000 Torr. Analysis of the data indicates that molecular association to form a dimeric species is the main source of enhancement of the thermal conductivity of both vapors. The enthalpy and entropy of association of the H_2O dimer are -3.59 kcal mol^{-1} and -18.59 cal deg^{-1} mol^{-1}, respectively. The enthalpy and entropy of association of the D_2O dimer are -3.66 kcal mol^{-1} and -18.67 cal deg^{-1} mol^{-1}, respectively. The measured enthalpy of association of the H_2O dimer is in agreement with recently reported ab initio molecular orbital calculations on the H_2O dimer. The entropies of association of the H_2O and D_2O dimers are calculated theoretically and are found to be in agreement with the measured values.

56957 Neutron-scattering investigation of the phonons in intermediate-valence Sm/sub 0.75/Y/sub 0.25/S. Mook, H.A.; Nicklow, R.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B: Condens. Matter;* **20**: No. 4, 1656-1662(15 Aug 1979).

Neutron-scattering techniques have been used to measure the phonons in intermediate-valence Sm/sub 0.75/Y/sub 0.25/S. Anomalies are found in the shape of the phonon dispersion curves and in the phonon widths that are attributable to mixed-valence effects. Phonon positions and widths are shown as a function of temperature. The greatest phonon softening and the largest phonon widths are found at the valence transition that occurs at 200 K. A screened-rigid-ion model has been used to fit the phonon dispersion curves. The model reproduces the general shape of the phonon dispersion data but fails to account for the anomalies.

56958 Direct measurement of electron emission from defect states at silicon grain boundaries. Seager, C.H.; Pike, G.E.; Ginley, D.S. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev. Lett.;* **43**: No. 7, 532-535(13 Aug 1979).

The first direct measurements of charge emission from silicon grain-boundary defect states have been made by monitoring the recovery of the nonequilibrium grain-boundary barrier capacitance. The density of grain-boundary states obtained in this fashion is in excellent agreement with the values found from deconvoluting room-temperature I-V data. These data are shown to suggest strongly that the double-depletion-layer/thermal-emission model gives a good description of silicon grain boundaries.

56959 (ORNL/Sub—7419/1) **Analytical evaluations of the endochronic nonlinear concrete model.** Goodpasture, D.W.; Burdette, E.G. (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering). [nd]. Contract W-7405-ENG-26. 131p. Dep. NTIS, PC A07/MF A01.

Comparison of the results of finite element (FEM) analyses were made with actual test data on prestressed concrete beam models. The ADINA computer program was used to perform the analyses with two material models for concrete. One material model was the concrete model furnished with ADINA and the second was the endochronic model as added by D.N. Fanning at Oak Ridge. Results of the prestressed concrete beam tests were compared to ADINA FEM results for both the regular and the endochronic material models. Published results of concrete specimens tested in uniaxial, biaxial, and triaxial states of stresses were collected and reduced to computer data files. The data files were then used to compare with results predicted by the endochronic theory in another computer program. The results of these comparisons, the source of the reference material, and a plot of the comparisons are included. A total of thirty two files were created in this phase of the study.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 56431, 56447, 56448, 56449, 56450, 56609, 56627

56960 Formation of color centers in ammonium perchlorate by x-ray irradiation at room temperature. Levy, P.W.; Goldberg, M. (Brookhaven National Lab., Upton, NY (USA)); Herley, P.J. *Radiat. Eff.;* **38**: No. 3-4, 231-238(Sep 1978).

Radiation induced color center formation has been studied in single crystal ammonium perchlorate. Large, high purity, water clear single crystals were uniformly irradiated normal to the c or 001 face with filtered 60 kV x-rays at room temperature. The radiation induced coloring, measured through the c face, can be resolved into four Gaussian shaped absorption bands whose peak energies and full widths are 6.72, 1.62; 4.81, 0.88; 3.91, 1.12; and 2.47, 0.72 eV. The 6.72 band lies at the 'band-gap' or 'edge' and could represent either a shift in the edge or the superposition of one or more bands on the edge. The other bands are, most likely, defect related color centers or trapped molecular species. The coloring contains a small unstable component, at most 10%, consisting of these bands and an additional one at 5.78 eV, width 0.35 eV, which has a negligible effect on coloring kinetic determinations. The color-centers vs. dose curves for the bands at 6.72 and 2.47 eV are linear. The curves for the 4.81 and 3.91 eV bands contain a linear and one saturating exponential component. The linear components appear to be related to a linear dose induced process observed in the thermal decomposition of irradiated ammonium perchlorate.

CHEMISTRY

56961 (ORNL—5485) **Chemistry Division annual progress report for period ending August 31, 1978.** (Oak Ridge National Lab., TN (USA)). Feb 1979. Contract W-7405-ENG-26. 235p. Dep. NTIS, PC A11/MF A01.

Separate abstracts were prepared for each section of the Annual Report. (JSR)

56962 (ORNL—5485, pp 3-23) **Coal-related research, organic chemistry, and catalysis.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Coal-related research covered: reactions of phenetole-α-^{14}C and -β- ^{14}C with tetralin, pyrolysis of 1, 2-diphenylethane in tetralin, dehydrogenation of coals and organic compounds with benzophenone, pyrolysis of 1-^{13}C-tetralin, structure of rauflexine and reflexine (indole alkaloids), surface properties of coal, and the mineral component of vitrinite. Catalysis studies include: purification and crystal structure of $ZnCl_2$, Nb(V) coordination in KCl-$AlCl_3$ melts, Scholl reactions of arenas in $SbCl_5$ melts, activation of cobalt-molybdate catalyst, characterization of catalyst supports, deflection of bimetallic ribbons by adsorbed gases, use of catalysis in production of energy sources, and studies of adsorption processes. 10 figures, 6 tables. (DLC)

ANALYTICAL AND SEPARATIONS CHEMISTRY

56963 Device for collecting and analyzing matrix-isolated samples. Reedy, G.T. (to Dept. of Energy). US Patent 4,158,772. 19 Jun 1979. Filed date 2 May 1978. 8p.

PAT-APPL-902,185.

A gas-sample collection device is disclosed for matrix isolation of individual gas bands from a gas chromatographic separation and for presenting these distinct samples for spectrometric examination. The device includes a vacuum chamber containing a rotatably supported, specular carrousel having a number of external, reflecting surfaces around its axis of rotation for holding samples. A gas inlet is provided for depositing sample and matrix material on the individual reflecting surfaces maintained at a sufficiently low temperature to cause solidification. Two optical windows or lenses are installed in the vacuum chamber walls for transmitting a beam of electromagnetic radiation, for instance infrared light, through a selected sample. Positioned within the chamber are two concave mirrors, the first aligned to receive the light beam from one of the lenses and focus it to the sample on one of the reflecting surfaces of the carrousel. The second mirror is aligned to receive reflected light from that carrousel surface and to focus it outwardly through the second lens. The light beam transmitted from the sample is received by a spectrometer for determining absorption spectra.

56964 Gaseous trace impurity analyzer and method. Edwards, D. Jr. (to Dept. of Energy). US Patent Application 970,842. 18 Dec 1978. 12p.

Simple apparatus for analyzing trace impurities in a gas, such as helium or hydrogen, comprises means for drawing a measured volume of the gas as sample into a heated zone. A segregable portion of the zone is then chilled to condense trace impurities in the gas in the chilled portion. The gas sample is evacuated from the heated zone including the chilled portion. Finally, the chilled portion is warmed to vaporize the condensed impurities in the order of their boiling points. As the temperature of the chilled portion rises, pressure will develop in the evacuated, heated zone by the vaporization of an impurity. The temperature at which the pressure increase occurs identifies that impurity and the pressure increase attained until the vaporization of the next impurity causes a further pressure increase is a measure of the quantity of the preceding impurity.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

56965 (ORO—5173-007) **Non-destructive determination of trace-element concentrations. Annual progress report, August 1979.** Gordon, G.E.; Zoller, W.H.; Walters, W.B. (Maryland Univ., College Park (USA). Dept. of Chemistry). Aug 1979. Contract EY-76-S-05-5173. 92p. Dep. NTIS, PC A05/MF A01.

Development and testing of the neutron-capture prompt γ-ray activation analysis method continued. A wide range of NBS Standard Reference Materials, USGS Standard Rocks, and other

materials have been analyzed in order to identify elements whose lines can be observed, to determine interferences and detection limits for each important γ ray of observable elements and to measure concentrations of observable elements for comparison with certified or other previous results. In most crustal samples, concentrations of 16 to 20 elements can be determined.

56966 (RISO-M—2141) **Sources of variability for the single-comparator method in a heavy-water reactor.** Damsgaard, E.; Heydorn, K. (Risoe National Lab., Roskilde (Denmark)). Nov 1978. 15p. (CONF-780794—1). Dep. NTIS (US Sales Only), PC A02/MF A01; Also available from Risoe Library, DK-4000 Roskilde, Denmark.

From 5. symposium on recent developments in activation analysis; Oxford, UK (17 Jul 1978).

The well thermalized flux in the heavy-water-moderated DR 3 reactor at Risoe prompted an investigation of to what extent a single comparator could be used for multi-element determination instead of multiple comparators. The reliability of the single-comparator method is limited by the thermal-to-epithermal ratio, and experiments were designed to determine the variations in this ratio throughout a reactor operating period. The bi-isotopic method using zirconium as monitor was chosen permit determination of the flux ratio with a precision sufficient to determine variations. One of the irradiation facilities comprises a rotating magazine with 3 channels, each of which can hold five aluminium cans. In another facility consisting of a pneumatic tube system, two samples were simultaneously irradiated on top of each other in a polyethylene rabbit. Experiments were carried out once a week for 4 periods. All samples were counted on a Ge(Li)-detector for ^{95}Zr, ^{97}sup(m)Nb and ^{97}Nb. The thermal-to-epithermal flux ratio was calculated from the induced activity, the nuclear data for the two zirconium isotopes and the detector efficiency. By analysis of variance the total variation of the flux ratio was separated into a random variation between reactor periods, and systematic differences between the positions, as well as the weeks in the operating period. If the variations are in statistical control, the error resulting from use of the single-comparator method in multi-element determination can be estimated for any combination of irradiation position and day in the operating period. With the measure flux ratio variations in DR 3 the single-comparator method introduces only insignificant errors in the determination of most elements.

CHEMICAL PROCEDURES

56967 (UCRL-Trans—11455) **Potentiometric readout of diazometric titrations using a copper-plated indicator electrode.** Matrka, M.; Drzdova, L.; Remes, M.; Sagner, Z.; Vana, J.; Zverina, V. Translated from *Chem. Prum.;* **28**: No. 2, 79-82(1978). 12p. Dep. NTIS, PC A02/MF A01.

A new method for potentiometric readout of diazometric titrations was developed, by using a copper-plated indicator electrode and a calomel reference electrode. The method offers relatively reliable and very accurate results during analysis of organic substances of mostly an aromatic nature, having -OH, -NH_2, -NHR, -$N(R)_2$ functional groups, or the so-called active methylene group in their molecule. The method is of major significance in determining dye intermediates, as well as drugs, photochemicals, etc.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 56065, 56149, 56150

SPECTRAL PROCEDURES

56968 **Method and apparatus for detecting and measuring trace impurities in flowing gases.** Taylor, G.W.; Dowdy, E.J. (to Dept. of Energy). US Patent 4,148,612. 10 Apr 1979. Filed date 7 Sep 1977. 6p.

PAT-APPL-831,196.

Trace impurities in flowing gases may be detected and measured by a dynamic atomic molecular emission spectrograph utilizing as its energy source the energy transfer reactions of metastable species, atomic or molecular, with the impurities in the flowing gas. An electronically metastable species which maintains a stable afterglow is formed and mixed with the flowing gas in a region downstream from and separate from the region in which the metastable species is formed. Impurity levels are determined quantitatively by the measurement of line and/or band intensity as a function of concentration employing emission spectroscopic techniques.

SEPARATION PROCEDURES

56969 (DOE/ER/00854—26) **Fundamental studies of separation processes. Technical progress report.** Rogers, L.B. (Georgia Univ., Athens (USA). Dept. of Chemistry). Aug 1979. Contract EY-76-S-09-0854. 16p. Dep. NTIS, PC A02/MF A01.

Three technical reports have been prepared which deal with the subjects of optimization in supercritical fluid chromatography, the gas chromatographic fractionations of the isotopes of carbon and oxygen in carbon monoxide, and a method for measuring the information content of a complex chromatogram. A fourth report, in preparation, compares different liquid chromatographic column packings with respect to the fractionation of a mixture of oligomers of polystyrene. Two other studies are relatively far along. One is a study of the recycle mode of operation as applied to gas chromatography. The second one deals with the fractionation of vanadium compounds in Boscan petroleum crudes. Finally, there are three other studies that are just getting started. The first involves an examination of pattern recognition as applied to coal tars and petroleum pitches. The second is exploring the possibility of using high-pressure gas chromatography to characterize carbon blacks and charcoals. The third is the long-delayed study of column-switching techniques that do not involve recycle.

56970 (RFP—2870) **Chemistry research and development progress report, May-October, 1978.** Miner, F.J. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). 30 Aug 1979. Contract EY-76-C-04-3533. 35p. Dep. NTIS, PC A03/MF A01.

Work in progress includes: calorimetry and thermodynamics of nuclear materials; americium recovery and purification; optimization of the cation exchange process for recovering americium and plutonium from molten salt extraction residues, photochemical separations of actinides; advanced ion exchange materials and techniques; secondary actinide recovery; removal of plutonium from lathe coolant oil; evaluation of tributyl phosphate-impregnated sorbent for plutonium-uranium separations; plutonium recovery in advance size reduction facility; plutonium peroxide precipitation; decontamination of Rocky Flats soil; soil decontamination at other Department of Energy sites; recovery of actinides from combustible wastes; induction-heated, tilt-pour furnace; vacuum melting; determination of plutonium and americium in salts and alloys by calorimetry; plutonium peroxide precipitation process; silica removal study; a comparative study of annular and Raschig ring-filled tanks; recovery of plutonium and americium from a salt cleanup alloy; and process development for recovery of americium from vacuum melt furnace crucibles.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 56729, 56733, 56875, 56980, 56981, 56999, 57523

56971 (CONF-781142—, pp 199-204) **Oxygen production by thermochemical air separation.** Erickson, D.C.; Erickson, C.A. Jr. (Energy Concepts Co., Annapolis, MD). May 1979.

From Chemical hydrogen energy systems contracts review; Washington, DC, USA (28 Nov 1978).

A feasibility study has been completed on a thermochemical approach to separating oxygen from air. Laboratory experimentation has verified the equilibrium behavior of the process reaction, and has shown that the reaction kinetics are sufficiently rapid to justify commercial development. Preliminary process design has shown this approach to require only half the energy required by current industrial oxygen processes.

56972 (COO—2807-18) **Experimental investigation of the chemistry of excited states of rare gases. Third quarterly progress report, April 15, 1979-July 15, 1979.** Setser, D.W. (Kansas State Univ., Manhattan (USA). Dept. of Chemistry). Jul 1979. Contract EY-76-S-02-2807. 19p. Dep. NTIS, PC A02/MF A01.

Photosensitized studies of Xe($^3P_1$) and Kr($^3P_1$) reactions with fluorine, chlorine, bromine, and iodine donors have been very productive. Work on the laser excitation methods for generating selected states of the rare gas atoms lying above the np^5,n + 1s set of levels continued.

56973 (COO—5015-1) **Mechanism of gas permeation through polymer membranes. Progress report, September 1, 1978-May 31, 1979.** Stern, S.A.; Kulkarni, S.S.; Mauze, G.R. (Syracuse Univ., NY (USA). Dept. of Chemical Engineering and Materials Science). May 1979. Contract ER-78-S-02-5015. 52p. Dep. NTIS, PC A04/MF A01.

A new, more exact derivation of the free-volume model of permeation is presented in this report. The free-volume parameters A/sub d/, B/sub d/, and γ have been determined for CO_2 in polyethylene from diffusivity measurements at 20 and 35°C and at pressures of up to 23 atm. The polyethylene was in the form of semicrystalline rods, and the measurements were made with a new type of high-pressure diffusivity apparatus operating under both isobaric and isothermal conditions. The above parameters were used in conjunction with the free-volume model to predict permeability coefficients for the transport of CO_2 through polyethylene membranes as a function of pressure. The values of the predicted perme-

ability coefficients were found to agree to within 35% or better (on the average) with those obtained directly from permeability measurements with thin polyethylene membranes. The agreement is within the expected limits, considering the assumptions of the free-volume model and the uncertainty in the diffusivity and permeability measurements. A method of determining free-volume parameters directly from permeability measurements was developed for dilute penetrant-polymer systems. This method was used to obtain values of A/sub d/, B/sub d/, and γ for CO_2, CH_4, C_2H_4, C_2H_6, and C_3H_8 in polyethylene membranes. The values of B/sub d/ and γ are in about the same range, respectively, as reported for other penetrant-polymer systems. No data appear to have been published previously for A/sub d/. According to the theory, B/sub d/ is thought to be related to the minimum hole size required for the displacement of a penetrant molecule in the polymer, and should depend on both the size and shape of the molecule. This was confirmed by a linear correlation of B/sub d/ with the effective molecular diameters of the above gases; these diameters make allowance for possible orientation of anisometric molecules during diffusion.

56974 (ENICO—1004) **Determination of the stability constants of a number of metal fluoride complexes and their rates of formation.** Hammer, R.R. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Aug 1979. Contract AC07-79ID01675. 111p. Dep. NTIS, PC A06/MF A01.

The stability constants of the fluoride complexes of Al^{+3}, H_3BO_3, Cr^{+3}, Cr^{+6}, Fe^{+3}, Gd^{+3}, Nb^{+5}, UO_2^{+2}, and Zr^{+4} were determined in 0.96 and 2.88 M HNO_3 solutions in the temperature range 25 to 60°C with a fluoride specific ion electrode. These data can be used to calculate the concentration of chemical species in solution and will be used to correlate solution properties with solution composition. The solubilities of some fluoride precipitates were also measured in nitric acid solutions. The rates of formation of the fluoborates, aluminum fluoride, and zirconium fluoride complexes were measured with a fluoride specific ion electrode at 25, 35, and 45°C. The rates of formation of all complexes, except BF_4^-, AlF^{+2}, and a fluoride complex with aluminum containing more than three fluorides associated with it, were too fast to measure with the instrumentation used.

56975 (LBL—9660) **Characteristics of very concentrated aqueous solutions.** Pitzer, K.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 53p. (CONF-790946—1). Dep. NTIS, PC A04/MF A01.

From Nobel symposium on chemistry and geochemistry of solutions at high temperature and pressure; Bofors, Karlskoga, Sweden (16 Sep 1979).

The electrical conductance and thermodynamic properties (activities) are described for the few aqueous electrolytes which have been investigated over the full range from fused salt to pure water. The activities are quite well represented by a simple equation originally proposed by van Laar for nonelectrolytes. Comments are made concerning the properties of various strong electrolytes up to saturation concentration and their dependence on temperature up to 300°C. These properties are accurately represented by virial-coefficient equations. Such equations have been used by Harvie and Weare to calculate all of the solubility relationships in the seawater-related system Na-K-Mg-Cl-SO_4-H_2O; the agreement with experiment is excellent.

56976 (RFP-Trans—277) **Application of a new equation for isotherms of adsorption on microporous materials.** Ginoux, J.L.; Bonnetain, L. Translated from *C. R. Hebd. Seances Acad. Sci., Ser. C;* **272**: 879-882(1971). 5p. Dep. NTIS, PC A02/MF A01.

The sorption of C_2H_4, CO_2, and N_2 on synthetic zeolites above and below the critical temperatures of these gases is represented in more satisfactory fashion by a new equation recently proposed by two authors than by Dubinin's equation. The values of the quantities adsorbed at saturation, obtained by extrapolation of the two formulas, are very close.

ISOTOPE EFFECTS

56977 (COO—10346-1) **Fundamental studies in isotope chemistry. Progress report, 1 December 1978-30 June 1979.** Bigeleisen, J. (Department of Energy, Washington, DC (USA). Div. of Chemical Sciences; State Univ. of New York, Albany (USA). Research Foundation). 1979. Contract AC02-79ER10346. 11p. Dep. NTIS, PC A02/MF A01.

This is a continuing program of basic research in isotope chemistry. Both theoretical and experimental studies complement one another to elucidate the fundamentals of isotope chemistry and to utilize this tool for the study of the fundamental properties of matter. Such studies have led to important separation processes of technological interest in the past and may provide the scientific base for future separation processes.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 56070

56978 **Experimental and computer modeling study of ^{81}Br isotope enrichment by isotopically selective, two-step laser photodissociation of HBr.** Zittel, P.F.; Little, D.D. (Chemistry and Physics Laboratory, The Ivan A. Getting Laboratories, The Aerospace Corporation, Los Angeles, California 90009). *J. Chem. Phys.;* **71**: No. 7, 2748-2764(1 Oct 1979).

Molecular bromine enriched in ^{81}Br has been observed mass spectrometrically following isotopically selective, two-step laser photodissociation of HBr in mixtures with NO. The dependence of isotopic enrichment and product yield on various experimental parameters was investigated. An extensive computer model was used to simulate the two-step enrichment process and gave fair agreement with experimental results. The computer model indicated that isotopic enrichment was limited in these experiments (i.e., $^{81}Br_2/^{79}Br_2 \simeq 1.6$, compared to the natural abundance ratio of 0.96) by Br isotope exchange during chemical scavenging and not by the initial two-step photodissociation process. Computer modeling studies of the effect of adding high pressures of rare gas to the HBr—NO mixtures suggest that much higher isotopic enrichments are possible. Enrichment of ^{81}Br in the C_2H_5Br product of isotopically selective, two-step laser photodissociation of HBr in C_2H_4 mixtures has also been observed experimentally.

56979 **Effects of alternative transition sequences on coherent photoexcitation.** Einwohner, T.H.; Wong, J.; Garrison, J.C. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., A;* **20**: No. 3, 940-947(Sep 1979).

Laser isotope separation schemes which require resonant photoexcitation of atoms or molecules with complex spectra will in general involve processes more complicated than a simple chain of transitions between successive pairs of energy levels. In the rotating-wave approximation these situations can be described by excitation graphs with side branches and cycles. For many cases a simple change of basis removes the time dependence of the interaction Hamiltonian and reduces the calculation of level populations and interlevel flows to an eigenvalue problem. By this method it is shown that a side branch with a large matrix element strongly inhibits the flow of population along the path to which it is attached. When several phase-locked lasers are employed, the populations and flows depend on certain linear combinations of the phases, one for each independent cycle in the excitation graph. In the simplest one-cycle example this phase dependence allows a continuous change from no population inversion to complete inversion.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 56729, 56973

56980 (ORNL—5485, pp 134-163) **Chemical physics.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Structures of the following were studied: tris-o-bipyridyl ruthenium (II) hexafluorophosphate, Co (acacen)(pyridine)$_2PF_6$, 2, 6-di-tert-butyl-1,4-benzoquinone, o-terphenyl, coronene ($C_{24}H_{12}$)(disorder), the complex {Th[$(CH_3)_5C_5]_2H(\mu$-H)]$_2$, α-D-glucose, 1,5-bidecaboran(14)yl $B_{20}H_{26}$ from γ radiolysis of decaborane), (4RS, 5SR) - 2,5-di-tert-butyl-4,5-dihydroxy-4-methylcyclopent-2-en-1-one (an oxidation product of 2,6-di-tert-butyl-4-methylphenol), a photochemical cycloaddition product, liquid neopentane and t-butyl alcohol, molten $SbCl_3$ and $ZnCl_2$, and liquid bromine. The chemiluminescent reaction $C_2 + NO \rightarrow CN^*(B^2\sigma^+) + CO + 1.69$ eV was studied using the crossed molecular beam technique. The reaction Cs + UF_6 CsF + UF_5 was also studied. Transmission and reflection of 100 - to 2500-eV H^+ and D^+ from carbon foils were studied for tokamacs.

56981 (ORO—3018-T1) **Physico-chemical investigation of some areas of fundamental significance to biophysics. Annual report, 1978-1979.** McGlynn, S.P. (Louisiana State Univ., Baton Rouge (USA). Dept. of Chemistry). 7 Aug 1979. Contract EY-76-S-05-3018. 151p. Dep. NTIS, PC A08/MF A01.

Work in progress includes: analyzing the lowest-energy Rydberg transitions of the alkyl halides; decomposition of a spectroscopic signal S into a system of bands; luminescence of aqueous systems; a study of the effects of small molecules on hydrogen bonding via glass transitions in ethanol; Rydberg/intravalence mixing in the S_2 state of azulene; ultraviolet photoelectron spectroscopy of carbonyls; and multi-photon processes.

56982 (UCRL—82155) **2,5 dimethyl 2,5 hexane diamine: a promising new curing agent for epoxy resins.** Rinde, J.A.; Chiu, I.; Mones,

E.T.; Newey, H.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 May 1979. Contract W-7405-ENG-48. 26p. (CONF-791116—2). Dep. NTIS, PC A03/MF A01.

From 11. national SAMPE technical conference; Boston, MA, USA (Nov 1979).

We have discovered a new curing agent for epoxy resins that has both interesting and useful properties. The compound, 2,5 dimethyl 2,5 hexane diamine (DMHDA) is a sterically hindered primary aliphatic amine that, as a curing agent for DGEBA epoxy resins, has the following desirable characteristics: (a) at room temperature it forms a stable B-stage resin; (b) it is a good wet-filament winding resin having a low viscosity (0.5 Pa.s) and a long gel time (21 h for a 30-g mass); (c) the cured resin properties are good - for example, the tensile strength is 86 MPa (12,500 psi), and the glass transition temperature is greater than 140°C when cured at 130°C.

56983 (UCRL—82623) **Surface chemistry and energy of untreated and thermally treated TATB and plastic bonded TATB composites.** Kolb, J.R.; Pruneda, C.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Apr 1979. Contract W-7405-ENG-48. 15p. (CONF-790632—9; CONF-7904108—1). Dep. NTIS, PC A02/MF A01.

From JOWOG-28; Albuquerque, NM, USA (11 Jun 1979).

The critical surface tensions of a series of polymers used as binders and thermally treated and untreated TATB and TATB PBXs have been measured. It appears that thermal aging decreases the surface energy of TATB, a material already low in surface energy. The surface characteristics of the HE dominate the PBX surface energetics. From studies of the acid-base interactions of polymer, TATB, and solvent systems it appears that treated and untreated TATB differ little in their ability to adsorb polymer-binders from solution. Kraton G 1650 appears slightly superior to Phenoxy PKHJ in its ability to coat TATB fillers. Kel-F 800 appears to be more weakly adsorbed and is affected to a greater extent by solvent acidity in its binding capacity.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 56828

56984 (N—79-13078) **Organic solids produced by electrical discharges in reducing atmospheres: molecular analysis.** Khare, B.N.; Sagan, C.; Zumberge, J.E.; Sklarew, D.; Nagy, B. (Cornell Univ., Ithaca, NY (USA). Lab. for Planetary Studies). Sep 1978. Contract NGR-33-010-101. 18p. NTIS PC A02/MF A01.

The complex brown polymer produced on passage of an electrical discharge through a mixture of methane, ammonia, and water, is analyzed by pyrolytic GC/MS. Pyrolyzates include a wide range of alkanes, alkenes, aromatic hydrocarbons, aliphatic and aromatic nitriles, pyrroles, and pyridine. Similar pyrolyzates are obtained from polypeptides and polynucleotides with hydrocarbon moieties. This polymer is remarkably stable up to 950 C; its degradation products are candidate constituents of planetary aerosols in the outer solar system and the grains and gas in the interstellar medium.

56985 (ORNL—5485, pp 173-180) **Electrochemistry.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Significant unpublished results are reported on the electrochemical behavior of titanium in acidic chloride solutions, corrosivity of carbon steel in concentrated chloride solution, method for analysis of polarization curves, and effect of redox couples on the kinetics of titanium dissolution. (JSR)

56986 **Passive iron: a semiconductor model for the oxide film.** Delnick, F.M.; Hackerman, N. (Sandia Lab, Albuquerque, NM). *J. Electrochem. Soc.;* **126**: No. 5, 732-741(May 1979).

Through a study of the kinetics of the hexacyanoferrate redox reaction on passive iron, a semiconductor model is proposed for the electronic structure of the oxide film. During passivation, an electron donor is incorporated into the oxide film for the formation and migration of interstitial iron ions. The high electronic conductivity of the film and the unusual Tafel behavior and nonintegral reaction orders of the hexacyanoferrate redox couple on passive iron are directly attributed to the presence of this donor level. The differential capacitance of the passive iron electrode further substantiates the proposed semiconductor electronic structure. The pH of the solution, and the presence of trace amounts of oxygen the solution strongly influence the electrocatalytic activity of passive iron electrodes by controlling the distribution of electronic energy levels in the oxide film.

56987 **Characterized semiconductor electrodes. I. Effect of processing variables on the photoelectrochemical properties of single crystal TiO_2 (rutile).** Wilson, R.H.; Harris, L.A.; Gerstner, M.E. (GE, Schenectady, NY). *J. Electrochem. Soc.;* **126**: No. 5, 844-850(May 1979).

The photoelectrochemical behavior of TiO;sub 2; (rutile) electrodes has been investigated as a function of electrode preparation. Mechanical polishing of the electrodes has been found to introduce a disturbed layer on the order of 1 ;mu;m deep. The experimental results indicate that this layer has an increased density of recombination sites. In addition, this layer affects the reduction process by which donors are created in TiO;sub 2;. Etching or annealing this layer can remove it or modify its behavior. The behavior of etched and annealed electrodes indicates that the absorption and/or reflection of light by TiO;sub 2; can be affected by electrode processing. The stability of TiO;sub 2; electrodes is discussed in terms of their usefulness in electrochemical studies.

56988 **Characterized semiconductor electrodes. II. Room temperature diffusion in a single crystal rutile electrode.** Harris, L.A.; Gerstner, M.E.; Wilson, R.H. (GE, Schenectady, NY). *J. Electrochem. Soc.;* **126**: No. 5, 850-855(May 1979).

The capacitance, spectral response, and volt-ampere characteristics of lightly reduced TiO;sub 2; photoelectrochemical electrodes are all significantly altered by immersion in concentrated acids or by operation at sufficiently negative voltages. These changes, which are reversible, are attributed to diffusion of protons along the c-axis channels of rutile. There is an apparent threshold voltage for appreciable accumulation of protons which are presumed to enter the crystal as H atoms.

PHOTOCHEMISTRY

56989 **Actinic-radiation curable polymers prepared from a reactive polymer, halogenated cyclic anhydride and glycidyl ester.** Pastor, S.D. (to National Starch and Chemical Corp.). US Patent 4,158,618. 19 Jun 1979. Filed date 17 Mar 1978. 12p.

A novel class of photosensitive polymers are disclosed which are prepared by the reaction, preferably in the presence of a catalyst, of a reactive polymer, a halogenated cyclic anhydride and glycidyl ester of an alpha, beta-unsaturated carboxylic acid. These polymers are capable of undergoing vinyl-type polymerization when exposed to actinic radiation.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 56989

56990 (BNL—26555) **Recent radiation effect studies on natural and synthetic rock salt for waste disposal applications.** Swyler, K.J.; Klaffky, R.W.; Levy, P.W. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 5p. Dep. NTIS, PC A02/MF A01.

The spectra (F band and colloid band) of irradiated synthetic rock salt were studied. Differences between synthetic and natural salt were found and are discussed. (DLC)

56991 (COO—2367) **ESR study of radiation damage in pyrimidines. Final report.** Benson, B.W. (Lehigh Univ., Bethlehem, PA (USA)). 29 Jun 1979. Contract EY-76-S-02-2367. 5p. Dep. NTIS, PC A02/MF A01.

Status of the studies of radiation effects on 5,5-substituted barbituric acids and nitro-substituted pyrimidines is summarized. No data is given. (DLC)

56992 (KBS-TR—56) **Radiolysis of buffer materials.** Allard, B.; Kipatsi, H.; Rydberg, J. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Oct 1977. 22p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

The effect of gamma irradiation on the properties of the possible buffer material bentonite (bentonite:quartz, 10:90) has been discussed, mainly in qualitative terms. Changes in ion exchange properties and lattice structure of the clay mixture due to irradiation in an aqueous solution have been studied. The production of gas (hydrogen) due to radiolysis has been determined as a function of the radiation dose. The resistance to corrosion of titanium in a radiation field has been demonstrated.

56993 **Process for the production of radiation curable coating compositions containing microcapsules.** Lee, Y.; Shackle, D.R. (to Mead Corp.). US Patent 4,161,570. 17 Jul 1979. Filed date 29 Apr 1977. 16p.

A process for producing a radiation curable coating composition containing microcapsules comprises the steps of preparing a dispersion of substantially discrete microcapsules in a continuous phase, the continuous phase comprising a liquid volatile solvent, preparing a liquid radiation curable suspending medium, the liquid radiation curable suspending medium comprising one or more ethylenically unsaturated organic compounds having at least one terminal ethylenic group per molecule, mixing the dispersion of substan-

tially discrete microcapsules in the continuous phase and the liquid radiation curable suspending medium with turbulent agitation to form an intimate mixture of the dispersion of microcapsules and the liquid radiation curable suspending medium, and applying heat and vacuum to the mixture, while maintaining the agitation, until the liquid volatile solvent is substantially removed from the mixture to form a dispersion of substantially discrete microcapsules in the liquid radiation curable suspending medium. The heat is applied to maintain the mixture at a temperature above the boiling point of the volatile solvent at the vacuum level.

56994 Radiation cured and monomer modified silicon elastomers. Eldred, R.J. (to General Motors Corp.). US Patent 4,158,617. 19 Jun 1979. Filed date 8 Mar 1976. 12p.

A method is described for the production of a tear resistant silicone elastomer, which has improved elongation properties. This elastomer is the radiation induced reaction product of a noncured methyl vinyl silicone resin (VMQ) and uniformly dispersed therein a blend of a polyfunctional acrylic crosslinking monomer and a filler.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

56995 (COO—4078-T1) **Interactive radiopharmaceutical facility between Yale Medical Center and Brookhaven National Laboratory. Progress report, October 1976-June 1979.** Gottschalk, A. (Yale Univ., New Haven, CT (USA). School of Medicine). 1979. Contract EY-76-S-02-4078. 32p. Dep. NTIS, PC A03/MF A01.

DOE Contract No. EY-76-S-02-4078 was started in October 1976 to set up an investigative radiochemical facility at the Yale Medical Center which would bridge the gap between current investigation with radionuclides at the Yale School of Medicine and the facilities in the Chemistry Department at the Brookhaven National Laboratory. To facilitate these goals, Dr. Mathew L. Thakur was recruited who joined the Yale University faculty in March of 1977. This report briefly summarizes our research accomplishments through the end of June 1979. These can be broadly classified into three categories: (1) research using indium-111 labelled cellular blood components; (2) development of new radiopharmaceuticals; and (3) interaction with Dr. Alfred Wolf and colleagues in the Chemistry Department of Brookhaven National Laboratory.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 56128, 56874, 56974

56996 (HEDL-TC—1503) **Decontamination of TRU contaminated metals.** Partridge, J.A.; Lerch, R.E.; Bosuego, G.P. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1979. Contract EY-76-C-14-2170. 18p. Dep. NTIS, PC A02/MF A01.

A laboratory study has been conducted to evaluate a metal decontamination process which uses a nitric acid solution of a redox agent to etch or dissolve the surface layer of the contaminated metal and thereby remove the contamination. The oxidizing species is regenerated electrolytically. it is concluded that a metal decontamination process based upon removal of contamination by treatment with a cerium(IV)-nitric acid solution (or other redox agent in nitric acid) is feasible and highly promising. 6 figures, 2 tables.

56997 (ORNL—5485, pp 69-80) **Separations chemistry.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Photochemistry, hydrolysis, and polymerization of the actinides, particularly Pu, are discussed. The OPAP (octylphenyl acid phosphate) process is being developed for recovering U from wet-process phosphoric acid. Investigations of separations of high-molecular-weight substances by filtration and of dispersion of miscible fluids in packed beds are reported. 12 figures, 3 tables. (DLC)

56998 Uranium oxide production. Tomaja, D.L. (to Phillips Petroleum Co.). US Patent 4,158,616. 19 Jun 1979. Filed date 25 Jan 1978. 6p.

Uranium oxide hydrate is produced by irradiating with light a solution of a suitable diluent, water-soluble uranium salt, carboxylate ion, and a rate-promoting amount of at least one suitable crown ether.

56999 Interaction of cesium with urania in uranium-plutonium oxide fast reactor fuel pins. Fee, D.C.; Johnson, C.E. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **78**: No. 1, 219-224(Nov 1978).

This note reports an investigation of the Cs-U-O system to define the composition of the cesium uranate formed at the fuel-blanket interface in irrdiated mixed-oxide fuel. In so doing, it is assumed that thermodynamic and kinetic data from out-of-pile experiments can be applied to predict in-reactor behavior. The experiments involved the exposure of powdered hyperstoichiometric urania (O/U atom ratio = 2.00 to 2.07) to gaseous cesium in a helium gas stream in a thermogravimetric analysis (TGA) apparatus. The cesium pressure was varied from 2.7 to 2700 Pa; the temperature range of the experiments was from 673 to 1273 K.

57000 Chemical thermodynamics of actinide elements and compounds. III. Miscellaneous actinide compounds. Cordfunke, E.H.P. (Stichting Energieonderzoek Centrum Nederland, Petten); O'Hare, P.A.G. (Argonne National Lab., IL (USA); International Atomic Energy Agency, Vienna (Austria). Div. of Research and Labs.). Vienna; IAEA (1978). 83p.

This compilation is part of a comprehensive assessment and selection of thermodynamic data for actinide compounds. It is based on a literature survey and most of the data have been recalculated from the results in the original literature citations. The compounds studied are actinium (hydroxide and sulfate); Thorium (acetate, formate, nitrate, oxalate, sulfate, sulfite, tungstate); Uranyl compounds (acetate, carbonate, chromate, formate, hydroxide, nitrate, sulfate, selenate); Uranium oxide hydrates; Uranium oxalate, sulfate and sulfite; Uranates of Ba, Ca, Cs, Li, Mg, Mn, Ni, K, Rb, Na, Sr, ammonium; Neptunium trioxide hydrate, neptunyl nitrates, neptunium oxalate and sulfate; Plutonium sulfate. The thermodynamic properties considered are: heat capacity, entropy, enthalpy, Gibbs free energy, heat of formation, and Gibbs free energy of formation. The presentation is divided into the main text giving critical evaluations of published data, and an Appendix containing thermodynamic tables for the compounds studied.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 56050, 56786, 56793, 56866, 56870

57001 (COO—4169-4) **Rate coefficients of combustion/fuel conversion reactions by High-Temperature Photochemistry. Progress report, September 1, 1978-August 31, 1979.** Fontijn, A.; Felder, W. (Aerochem Research Labs., Inc., Princeton, NJ (USA)). Sep 1979. Contract EG-77-C-02-4169. 44p. (AeroChem-TN—208). Dep. NTIS, PC A03/MF A01.

Reliable kinetic data on isolated elementary combustion reactions spanning a broad temperature range are required for modeling and scaling studies aimed at improving the performance of, and reducing the pollutant formation from, fossil-fuel burning devices. Such data are generally not available. In the present work a new technique, High-Temperature Photochemistry (HTP), has been successfully developed to provide such data. It combines: (1) the technology of the high-temperature fast-flow reactors we developed to study kinetics of metal atom/oxide reactions in the 300-1900 K range with (2) the methodology of the pulsed photolysis technique, which although used widely for study of such combustion reactions, has previously been limited to studies at or near room temperature. This report describes the HTP reactor, its operation, and the first completed study with it concerning the benchmark reaction, $O + CH_4 \rightarrow OH + CH_3$. The present data which extend from 400 to 1600 K overlap the previous low temperature (250 to 950 K) and high temperature (1200 to 2600 K) measurements of $k_1(T)$ and show a slightly curved Arrhenius plot, generally in agreement with the more reliable earlier work and with calculations for a linear transition state. The present data can be fit by the empirical rate coefficient expression $k_1(T) = (6 +- 3) \times 10^{-9} \exp[-(9900 +- 700)/T] + (7 +- 2) \times 10^{-11} \exp[-(5000 +- 100)/T]$ ml molecule^{-1} s^{-1}.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 56833

57002 (CONF-790802—64) **Applications of endochronic plasticity in the dynamic finite element analysis of structures.** Velentin, R.A.; Hsieh, B.J.; Lin, H.C. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A fundamental feature of the endochronic theory of plasticity is that it does not require the definition of a yield surface. Thus, when compared with classical methods for the analysis of dynamic, elastic-plastic response problems, one would expect the theory to possess a significant advantage in terms of overall computational efficiency. The paper describes an attempt to evaluate this potential

advantage in terms of a finite element implementation. Described is the finite element formulation, validation of results by comparison with experimental studies on the explosive loading of plates, numerical simulation of high velocity impact problems, and an evaluation of certain uniqueness and numerical stability questions.

57003 (NP—23910) **Generation of high voltage pulses from inductive energy stores by the use of exploding wires.** Schwarz, U. (Technische Univ. Braunschweig (Germany, F.R.). Fakultaet fuer Maschinenbau und Elektrotechnik). 1977. 121p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Thesis.

This thesis presents investigations and considerations on the generation of high voltages from inductive energy stores charged by a dc power supply. For the proposed method of voltage generation storage coils are needed which can bear high voltages. Design criteria for cylindrical coils for the use at room temperature are given, which show that these coils can withstand voltages of several 100 kV even if geometrically designed for high energy content. To minimize the power for charging of such a coil it helps to make the inner ohmic resistance of the dc power source lower than the ohmic resistance of the coil. The discussion of the feasibility of the proposed system shows that it becomes useful when using a storage coil with a total volume of more than 1 m^3. Such coils can be built for high voltages and can be charged with a power of some 100 kW to an energy content up in the MWs-range. Finally two possible applications are described, one with an ohmic load and one with a capacitive load.

57004 (RE-D—79-220) **Evaluation of compression-type tube fittings for use at INEL.** McBride, J. (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1979. Contract EY-76-C-07-1570. 186p. Dep. NTIS, PC A09/MF A01.

INEL has been using mostly Swagelok compression-type tube fittings for more than 20 years. Suppliers of other similar lines of tube fittings have complained that fittings for warehouse stores should be purchased on a competitive bid basis. Previous studies on this subject have recommended the continued use of Swagelok on a sole-source basis. This policy has been maintained, but not formally stated to suppliers. Continuous marketing pressure from Gyrolok and Parker-Hannifin has resulted in a decision by the EG & G Idaho, Inc., Materiel Division and DOE-ID personnel to formulate a uniform policy on the warehousing of compression-type tube fittings. This report was prepared to give the EG & G Idaho, Inc., Materiel Division and DOE-ID management the best available information necessary to make a rational decision. It is concluded that the Swagelok fitting is the best available product of the three evaluated from the standpoints of technical adequacy and overall cost to the Government. It is recommended that INEL warehouse only the Swagelok brand.

57005 **Lower bounds to fundamental frequencies and buckling loads of columns and plates.** Shih, P.Y. (Univ. of New Mexico, Albuquerque); Schreyer, H.L. *Int. J. Solids Struct.;* **14**: 1013-1026(1978).

A general derivation of expressions for lower bounds to fundamental frequencies and buckling loads is given for the class of structures governed by linear elastic theory in the prebuckling state. These expressions involve two Rayleigh quotients both of which are upper bounds for the fundamental frequency under a prescribed load. The displacement trial functions must satisfy force and kinematic continuity but no other conditions are required. Thus, if appropriate high order basc functions are used, the finite element procedure can be used to systematically narrow the difference between the upper and lower bounds. The theory is illustrated with several column and plate problems. The finite element method is applied to uniform and nonuniform columns with a representative set of boundary conditions. Elementary trial functions are used to show that reasonable bounds can also be obtained for plates subjected to known states of stress. Since the lower bound is obtained with a variation of the classical technique of Rayleigh, these results indicate that the method may be suitable for conservatively estimating buckling loads and fundamental frequencies of engineering structures.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 56366, 56380, 56823, 57031, 57043, 57044, 57045, 57275, 57381, 57383, 57384, 57486, 57489, 57490

57006 (CONF-790815—19) **Vapor locking and heat transfer under transient and steady state conditions.** Chen, C.J.; Wang, S.T.; Dawson, J.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

The study was undertaken to determine the vapor locking in the cooling channels of a cryostable superconducting magnet, to investigate the heat transfer characteristics under steady state and transient conditions, and to study the effects of vapor accumulation of the multiple coil layers. Based on the experimental results obtained the following conclusions can be made: (1) the critical steady state heat flux for the transition from nucleate boiling to film boiling is about 0.4 w/cm^2; (2) the critical transient energy density for the boiling transition is about 100 mJ/cm^2; (3) the front channel is easier to reach the film boiling regime than rear channel, due to that the wetted area of front side is more than the wetted area of rear side; and (4) no temperature rise greater than 1°K is possible if the heat flux does not exceed the critical heat flux under steady state condition or the energy density does not exceed the critical energy density under transient condition.

57007 (CONF-790815—24) **Cryostability measurements under steady state and transient conditions.** Huang, Y.; Wang, S.T.; Turner, L.R.; Lieberg, M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

In order to achieve the designed performance of a superconducting magnet, one of the key points to be considered carefully is the stability of the magnet. For a large superconducting magnet with huge stored energy, one always demands that the magnet is thermally stabilized. Since nobody really knows the limit of the size of the disturbance in a large magnet, and since a large magnet is economically permitted to operate at a relatively low current density, the MHD magnet to be built for the Coal-Fired Flow Facility (CFFF) at the University of Tennessee Space Institute is designed to adhere to the absolute stability criterion. Although for the compactness reason, because of the air shipment, the US SCMS (U-25) superconducting dipole magnet was designed to have higher current density and can recover following a generation of a local normal zone. To test the stability characteristics of these two magnet systems, the US SCMS conductor and the CFFF Grade A conductor were used to construct various samples. Two of these samples were short sample type set ups. They were easy to make and could furnish quick and rather reliable information. But, to eliminate the end effect and to look deeply into the stability of the conductor, two test samples with fairly long conductors also were made. The experimental setup and test results are discussed. (TFD)

57008 (INIS-mf—4820, pp 31-37) **Cooled superconducting magnetic system of complicated configuration for a thermonuclear facility.** Glasov, B.V.; Drui, O.S.; Zhukov, V.N.; Kitaevskii, L.Kh.; Kurnosov, V.I.; Merzlikin, V.A.; Nikolaev, G.T.; Skibenko, E.I.; Tkhoryak, F.A.; Yuferov, V.B. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The results of investigation for developing partly stabilized superconducting magnetic systems (SMS) of complex configuration with indirect cooling at a stored energy of 1 MJ, and a current density of 1.6×10^4 A/cm^2 are presented. The design features of SMS, which is a combination of two solenoids with helical and annular windings, are described in detail. The diagram of cryogenic cooling of SMS with the aid of helium is given. It is shown that in order to reduce thermal stresses in the winding during its polymerization, cooling and heating, the polymerization temperature should be reduced to 300-320 K. The time of transition of SNS to the normal state took less than 1s. It is shown that elimination of the emergency situations requires devices for fast (10sup(-3)-10sup(-4)s) dotection of the normal phase in the winding and a circuit for energy extraction in less than 1s.

57009 (INIS-mf—4820, pp 38-41) **Study on superconducting solenoids with a high-current density for plasma systems.** Glasov, B.V.; Drui, O.S.; Kurnosov, V.I.; Merzlikin, V.A.; Nikolaev, G.T.; Skibenko, E.I.; Yuferov, V.B. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The object of the investigation was to establish the possibility of developing a superconducting, partly stabilized magnetic system (SMS). A multiturn solenoid with an inner diameter of 45 cm, an outer diameter of 52 cm, and a winding of 36 cm length was investigated. The solenoid was made of the KETV-2-NT cable of 1.5 mm diameter. The number of turns in the solenoid is 4386, its inductivity being 6.83 H. A glass cloth with a silicone varnish is placed between the winding turns. Liquid nitrogen, benzine, and glycerine with alcohol cooled to 4.2 K are used as the compound. The calculation of the parameters of the SMS transition to the normal state is in a good agreement with experiment. The maximum current obtained in the solenoid is 400 A. The preliminary testing of the cable, its rational arrangement on the winding, and the compounding of the solenoid reduce the effect of current degradation to 20%. The expected design current density of the solenoid is 1.6×10^4 A/cm^2 in a field of 5.3 T with a stored energy of 0.7 MJ.

57010 (INIS-mf—4820, pp 10-13) **High-current superconducting switches.** Glukhikh, V.A.; Kostenko, A.I.; Monoszon, N.A.; Stolov,

A.M.; Tishchenko, V.A.; Trokhachev, G.V.; Yudakov, Yu.V. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Presented are the results of investigations on the development of the design and the manufacturing process for making superconducting switches (SCS) without a normal metal shunting the superconductor. The SCS is designed as a packet of bifilar strip of Ti-Nb foil with insulating interlayers of glass cloth with subsequent epoxy resin potting. SCS was used to extract an energy of 50 kJ from an inductive storage at a maximum power of 25 Mw. A limiting current of 2600-2700 A was achieved on linear increase of the current at the rate of 100-200 A/s. With an exponential increase of the current with a time constant of 60-70 μs, a limiting current of 2100 A was achieved, which corresponds to a current density of $4x10^5$ A/cm² in the superconducting foil. SCS may be used as sources of powerful electric pulses for thermonuclear devices.

57011 (INIS-mf—4820, pp 14-20) **Functional model of a high-current high-voltage superconducting switches.** Menke, Kh.; Shishov, Yu.A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Considered are problems of superconducting switches (SS) for energy extraction from magnets at a current of several kiloamperes and a voltage of several kilovolts with a time for transition to the normal state of <0.5 ms. SS is made of a wire of 0.5 mm diameter containing 19 strands of Nb-Ti alloy of 65 μm diameter. The wire matrix was etched out, 19 wires of 4.5 m length were braided together. On each of three groups of wires a heater wire of constantan of 0.12 mm diameter and 6 m length was wound. A second heater intended for slow heating during current feeding into the magnet, is wound over the braid. The wires and heaters are parallel connected and impregnated by an epoxy compound. The following main parameters were obtained in SS testing: critical current of 920 A, resistance in the normal state of 2.5 Ohm, and minimum delay time of 0.2 ms at a nominal current of 0.8 of the critical one.

57012 (INIS-mf—4820, pp 21-24) **Development and investigation of nonstationarily stabilized superconducting solenoids.** Anashkin, O.P.; Gavrilin, A.I.; Keilin, V.E.; Klimenko, E.Yu.; Lykov, V.V.; Shleifman, V.Kh. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The main characteristics of nonstationarily stabilized superconducting solenoids with compounded windings are presented. In solenoids with an inner diameter of 40 mm, fields of induction of 9 T were obtained. The maximum field was 9.6 T at a current of 150 A. The technique of compounding of windings is described in detail. A glass textile previously impregnated with a binder is used as interlayer insulation. Solenoids with compounded and conventional windings showed identical results in testing.

57013 (LA-UR—79-2309) **Helium: how do we put off that projected $5000/Mcf cost as far into the future as possible - or shouldn't we even try.** Hammel, E.F. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 30p. (CONF-790815—26). Dep. NTIS, PC A03/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

The dwindling supplies of helium and the problems of imposing conservation measures are discussed. (TFD)

57014 (LBL—9701) **Forced two phase helium cooling of large superconducting magnets.** Green, M.A.; Burns, W.A.; Taylor, J.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 24p. (CONF-790815—27). Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

A major problem shared by all large superconducting magnets is the cryogenic cooling system. Most large magnets are cooled by some variation of the helium bath. Helium bath cooling becomes more and more troublesome as the size of the magnet grows and as geometric constraints come into play. An alternative approach to cooling large magnet systems is the forced flow, two phase helium system. The advantages of two phase cooling in many magnet systems are shown. The design of a two phase helium system, with its control dewar, is presented. The paper discusses pressure drop of a two phase system, stability of a two phase system and the method of cool down of a two phase system. The results of experimental measurements at LBL are discussed. Included are the results of cool down and operation of superconducting solenoids.

57015 Casting of dendritic Cu-Nb alloys for superconducting wire. Verhoeven, J.D.; Schmidt, F.A.; Gibson, E.D.; Ostenson, J.E.; Finnemore, D.K. (Ames Laboratory-USDOE, Department of Materials Science and Engineering, and Department of Physics, Iowa State University, Ames, Iowa 50011). *Appl. Phys. Lett.;* **35**: No. 7, 555-557(1 Oct 1979).

Consumable electrode-arc-casting techniques have been developed for the preparation of large billets of dendritic Cu-Nb alloys which are suitable for the fabrication of multifilamentary superconducting wire. The dendrite structure is somewhat more coarse than chill cast material but metallographic and chemical analyses show acceptably small radial and longitudinal segregation. The billets can be drawn to wire with no intermediate anneals. Both external diffusion after tin plating and internal diffusion of wire with a tin core can be used to transform the Nb filaments to Nb_3Sn. The arc cast wire displays J/sub c/ values equivalent to previously reported values on in situ wire at high fields, but somewhat lower values at low fields.

57016 Elimination of Kirkendall voids in superconducting composites. Cogan, S.; Holmes, D.S.; Rose, R.M. (Department of Materials Science and Engineering and Center for Fusion Energy, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **35**: No. 7, 557-559(1 Oct 1979).

Kirkendall void formation, which has hitherto prevented the use of the external diffusion technique for the manufacture of practical multifilamentary superconducting composites, can be suppressed by using solution anneals to eliminate sites for heterogeneous void nucleation.

PROTECTIVE STRUCTURES AND EQUIPMENT

57017 Comparison of a sodium chloride aerosol filter test method to silica-dust and silica-mist filter test methods. Lowry, P.L.; Revoir, W.H. (Los Alamos Scientific Lab., NM). *Am. Ind. Hyg. Assoc. J.;* No. 39, 709-716(Sep 1978).

Two types of resin-impregnated electrostatic felt filter materials were tested at LASL to measure NaCl aerosol penetration, and were then shipped to four respirator manufacturers where silica-dust and silica-mist tests were performed. Samples of these two filter materials were also shipped to the NIOSH Division of Physical Sciences and Engineering (DPSE) Laboratory in Cincinnati, Ohio, where the materials were again evaluated for NaCl aerosol penetration. The purpose of the NIOSH DPSE NaCl aerosol evaluation was to determine the reproducibility of NaCl aerosol penetration results. Test procedures and results are described.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 56078

57018 Sample taking device for toxic and/or radioactive substances. Finsterwalder, L.; Zeh, H.; Schaarschmidt, U. (to Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH). US Patent 4,160,382. 10 Jul 1979. Filed date 16 Sep 1977. 6p.

An apparatus for taking samples of toxic and/or radioactive liquid substances by introducing such substances into sample vessels includes a holder for holding such a vessel, at least one needle head filling system composed of upwardly pointing hollow needles for introducing a sample of one such substance into such a vessel at a filling position, and inlet and outlet conduits for pneumatically conveying vessels to or from the holder at a transfer position. The holder is composed of a turntable having a sleeve for accommodating such vessel and is mounted to undergo rotary movement to convey a sample vessel held in the sleeve between the filling and transfer positions. The apparatus further includes a stand supporting the filling system below the holder and a lifting device connected for imparting a translational movement to the holder to bring a vessel in the holder to operative association with the filling system. The lifting device is arranged so that the translational movement which it produces is independent of the rotary movement of the turntable.

SHIPPING CONTAINERS

57019 (INIS-mf—4764) **Sea transport of used nuclear fuel and radioactive disposals to a Swedish central store.** (Salenrederierna AB, Stockholm (Sweden)). Oct 1977. 103p. (In Swedish, English). Dep. NTIS (US Sales Only), PC A06/MF A01.

A vessel for transporting used nuclear fuel and radioactive disposals from the power stations at Ringhals, Barsebaeck, Simpevarp and Forsmark to a central store has been projected. Safety aspects, technical and economical aspects have been taken into consideration with regard to the actual volume of goods to be transported. Three different types of vessels are presented and a specification is given for the main alternative. A safety study of the main alternative is shown, regarding collision safety, fire risks and fire extinguishing equipment.

TRANSPORT AND STORAGE FACILITIES

REFER ALSO TO CITATION(S) 57029

MINING AND DRILLING EQUIPMENT AND FACILITIES

57020 (SAND—79-0084C) **Recent developments in drill bit technology.** Varnado, S.G. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 19p. Dep. NTIS, PC A02/MF A01.

The drilling environment in deep oil and gas wells and in geothermal wells is generally hostile. Formation temperatures of 150 to 350°C are commonly encountered. New developments in drilling technology are required to reduce the cost of drilling wells under these conditions. In the United States, the Department of Energy is funding research directed at assisting industry in developing the techniques required for drilling in hostile environments. Among the most recent developments in high temperature drill bits are the use of Stratapax cutters in drag-type bits and the use of improved, high-temperature materials in conventional roller cone bits. The paper describes recent developments in these two areas.

LASERS

REFER ALSO TO CITATION(S) 57077, 57512, 57513

57021 (GEPP-TIS—445) **Displacement characteristics of a glass-ceramic insulator in a vacuum tube envelope sealing process.** Spears, R.K. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 12 Oct 1979. Contract EY-76-C-04-0656. 16p. Dep. NTIS, PC A02/MF A01.

The objective of the study was to examine the flow characteristics of two glass-ceramic compositions (used for high voltage insulation in a vacuum tube envelope) during sealing to molybdenum by determining the temperature at which the glass starts to flow and the temperature at which it becomes fully deformed. The initial softening temperature was between 630 and 715°C; the deformation temperature ranged from 890 to 1010°C.

57022 (LA-UR—79-1655) **Overvoltage protection by point-plane spark gaps.** Scarlett, W.R.; Riepe, K.B. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-791028—2). Dep. NTIS, PC A02/MF A01.

From Conference on electrical insulation and dielectric phenomena; Whitehaven, PA, USA (21 Oct 1979).

In electron-beam-controlled discharge CO^2 lasers, such as those used in the Antares and Helios laser-fusion drivers at the Los Alamos Scientific Laboratory (LASL), protection needs to be provided against possible damage due to overvoltage. A passive (self-breakdown) point-plane spark gap has been developed and successfully used in the Helios power amplifiers which operate at voltages up to 300 kV. A gap of similar design is planned for use in the Antares power amplifiers which operate at 550 kV. These gaps must reliably hold off the normal discharge voltage, but break down with short delay if overvoltaged, diverting the discharge energy to a resistor. A prototype of the Antares gap has been built and is undergoing tests. Parameters being investigated include voltage polarity, gap spacing, gas composition, and gas pressure. Results of these measurements and the operational experience of the Helios gaps will be presented.

57023 (LA-UR—79-2176) **Investigation of efficiency optimization in free electron lasers.** Kwan, T.J.T. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 25p. (CONF-790853—2). Dep. NTIS, PC A02/MF A01.

From ONR workshop on electron generators of coherent radiation; Telluride, CO, USA (13 Aug 1979).

The dynamics of trapped particles in the presence of the wiggler magnetic field and the electromagnetic radiation field in free electron lasers were investigated. From the results of computer simulations, it was found that, for a given set of parameters, the efficiency of energy extraction from the electron beam maximizes at a particular intensity of the electromagnetic radiation. Based on the physical argument of the dynamics of the trapped particles, a criterion which predicts accurately the optimum intensity of the electromagnetic radiation was obtained. (TFD)

57024 **Theoretical study of the deexcitation of KrF and XeF excimers by low-energy electrons.** Hazi, A.U.; Rescigno, T.N.; Orel, A.E. (Theoretical Atomic and Molecular Physics Group, Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Appl. Phys. Lett.;* **35**: No. 7, 477-479(1 Oct 1979).

Cross sections and rate constants for electron deexcitation of the excimer states of KrF and XeF have been calculated using a modified impact parameter method, and large ab initio wave functions. The superelastic processes are dominated by the B→X transitions with thermal rate constants of 7×10^{-8} and 3×10^{-8} cm^3/sec for XeF and KrF, respectively.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 57269

57025 (COO—4051-45) **Availability: the concept and associated terminology.** Kestin, J. (Brown Univ., Providence, RI (USA)). Jul 1979. Contract EY-76-S-02-4051. 27p. Dep. NTIS, PC A03/MF A01.

After a brief historical introduction, expressions for the available work of a thermodynamic system are derived while the latter interacts with the passive environment. The passive environment is modelled as a union of three idealized reservoirs, one each of energy, volume, and matter. The available work is defined as the optimum amount - largest or smallest - exchanged in the circumstances, given a prescribed initial and final state of the system. Two types of systems are studied: closed systems and open flow systems, and the interaction is progressively enlarged to include, in three steps, the transfer of heat, the transfer of work and the transfer of matter. Available work is the difference between the exergy of states 1 and 2, the exery of a state being defined as the optimum work achievable against a final state which is one of equilibrium with the surroundings. It is shown that exery so defined is not a unique quantity for a given system and state, because it also depends on the kind of interaction permitted and, therefore, on the kind of equilibrium achieved.

57026 (INKA-Conf—78-216-002) **Heat exchange in stirrer vessels in monophase liquids.** Poggemann, R. (Dortmund Univ. (Germany, F.R.). Lehrstuhl fuer Thermische Verfahrenstechnik). 1978. 36p. (In German). (CONF-781252—1). NTIS (US Sales Only), MF A01.

From GVC lecture meeting on advances in chemical engineering; Duesseldorf, F.R. Germany (4 Dec 1978).

Portions of document are illegible.

In the field of heat transfer in stirrer vessels in monophase systems, the heat transfer behavior in the hydrodynamic regions, the description of heat exchange on the basis of similarity theory, the precalculation of heat transfer by means of empirical formulas the efficiency of heat exchange of several types of stirrer vessels, down- and upscaling in stirred systems for heat supply and heat removal, and the heat transfer in static mixers are dealt with. A detailed review of the present state of knowledge on heat transfer on the basis of the empirical formulae given in the relevant literature is presented.

57027 (LBL—9092) **Developing flow and heat transfer in strongly curved ducts of rectangular cross-section.** Yee, G.; Humphrey, J.A.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 57p. (CONF-791205—11). Dep. NTIS, PC A04/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

A numerical study of heat transfer in 90°, constant cross-section curved duct, steady, laminar flow is presented. The work is aimed primarily at characterizing the effects of duct geometry on heat transfer by considering, especially, the role of secondary motions during the developing period of the flow. However, due consideration has also been given to varying initial conditions of velocity and temperature at the entrance section to the duct. In addition, an assessment is made of the relative contributions of individual duct walls to heat transfer in the flow. It is found that, in general, heat transfer increases with Dean number with the largest transfer rates occurring through the duct side walls and outer-curvature wall. Duct geometries with aspect ratio greater or smaller than unity have weaker secondary motions and are less effective for heat transfer. Similarly, plug-flow entrance profiles for velocity retard the development of cross-section flow thus inhibiting a significant contribution to heat transfer. It is concluded that short ducts with strong curvature and intense secondary motions can be as effective for heat transfer as longer ducts which are less strongly curved. Calcuations are based on fully elliptic (in space) forms of the transport equation governing the flow. They are of engineering value and are limited in accuracy only by the degree of computational mesh refinement. A comparison with calculations based on parabolic equations has been made and it is shown how the latter can lead to erroneous results for strongly curved flows.

57028 (SAND—79-1373C) **Finite elemcnt analysis of volumetrically heated fluids in an axisymmetric enclosure.** Gartling, D.K. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 9p. (CONF-7906129—1). Dep. NTIS, PC A02/MF A01.

From 3. international symposium on finite element methods in flow problems; Banff, Alberta, Canada (10 Jun 1979).

A general purpose finite element computer code has been used to analyze the steady state and transient response of a confined fluid that is heated volumetrically. The numerical procedure is demonstrated to be capable of resolving flow fields of considerable complexity without undue computational expense. Results are dis-

cussed for a Grashof number range (4.0×10^4 to 4.0×10^6) in which the flow varies from a steady, single cell configuration to a multiple cell configuration that includes a periodic interaction.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 56399

SAFETY ENGINEERING

57029 (INKA-Conf—78-012-005) **Discharges following electrostatic charging in large storage silos.** Maurer, B. (BASF A.G., Ludwigshafen am Rhein (Germany, F.R.)). 1978. 27p. (In German). (CONF-7809151—2). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Annual meeting of chemical engineers; Aachen, F.R. Germany (27 Sep 1978).

Very high electrostatic charging can be produced in pneumatic transport of nonconductable dusts or granulates. Due to this charge accumulation, discharges of various kinds and energy densities may be released in the transport system. Since avoiding sources of ignition in the handling of burnable materials is important as a protective measure against fires or explosions, the ability of these discharges to ignite must be tested. The conditions necessary to form sparks, brush and sliding brush discharges, and lightning discharges in large-volume silos are discussed. Their capability to ignite burnable dust-air mixtures is calculated. Measures for preventing the occurrence of ignitable discharges in solid-air mixtures are discussed.

57030 (UCRL—83117) **Flammability of floor covering.** Alvares, N.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Aug 1979. Contract W-7405-ENG-48. 22p. (CONF-7810202—1). Dep. NTIS, PC A02/MF A01.

From 4. annual fire protection seminar; Menlo Park, CA, USA (27 Oct 1978).

The goal in analyzing the characteristics of performance tests for simple flammability risk situations was to find out what controlling parameters influence a test's correspondence to reality. Delphi analysis was used to identify tests that are representations of flammability risk. Fault-tree logic diagrams indicated that fire-source parameters and test material-orientation were the controlling conditions in all performance tests.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 57003, 57040

57031 (CONF-790815—23) **Superconducting notch filter.** Pang, C.S.; Falco, C.M.; Kampwirth, R.T.; Schuller, I.K.; Hudak, J.J.; Anastasio, T.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

Results of a preliminary investigation of a superconducting notch filter for possible application in the 2 to 30 MHz high frequency (HF) communication band are presented. The circuit was successfully implemented using planar geometry so that closed cycle refrigeration could be used to cool circuits fabricated from high T/sub c/ Nb_3Sn or Nb_3Ge thin films. In the present design, circuit Q's of about 2×10^3 were obtained with 50-ohm source and output impedance. (TFD)

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 56008

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 56014, 57125

PARTICLE ACCELERATORS

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

57032 (LA-UR—79-2330) **General least-squares fitting procedures to minimize the volume of a hyperellipsoid.** Wadlinger, E.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—2). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Several methods for determining the shape parameters, which in two dimensions are the Courant-Snyder parameters, and the volume of an ellipse or hyperellipse that represent a set of phase-space points in a two or more dimensional hyperspace are presented. The ellipse parameters are useful for matching a beam to an accelerating or transport system and in studies of emittance growth. The fitting procedure minimizes the total volume of a hyperellipse by adjusting the ellipse shape parameters. The total volume is the sum of the individual particle volumes defined by the hyperellipse that passes through the phase-space point of a particle. A two-dimensional space is considered first; the results are then generalized to higher dimensions. Computer programs using these techniques were written. 1 figure.

57033 (LA-UR—79-2499) **RF quadrupole beam dynamics design studies.** Crandall, K.R.; Stokes, R.H.; Wangler, T.P. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 13p. (CONF-790927—17). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The radio-frequency quadrupole (RFQ) linear accelerator structure is expected to permit considerable flexibility in achieving linac design objectives at low velocities. Calculational studies show that the RFQ can accept a high-current, low-velocity, dc beam, bunch it with high efficiency, and accelerate it to a velocity suitable for injection into a drift-tube linac. Although it is relatively easy to generate a satisfactory design for an RFQ linac for low beam currents, the space-charge effects produced by high currents dominate the design criteria. Methods have been developed to generate solutions that make suitable compromises between the effects of emittance growth, transmission efficiency, and overall structure length. Results are given for a test RFQ linac operating at 425 MHz.

57034 (LA-UR—79-2502) **Statistical approach to the estimation of beam spill.** Boicourt, G.P.; Jameson, R.A. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—3). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Computer codes, which transform a number of pseudoparticles through a simulated machine, form the backbone of accelerator design techniques. When minimization of beam loss within the machine is a primary design objective, it becomes necessary to consider beam behavior in detail, and questions of both the physics and computational aspects of the simulation are raised. Within the constraints of the former, the effectiveness of the latter can be increased for a given amount of computer resources by the use of statistical techniques. A statistical approach to determining the maximum beam size and hence required aperture of a machine is described and illustrated. The method draws upon statistical theory to treat the maximum radius attained by a finite group of particles passing through an accelerator as a statistical variable. Once the distribution of this variable is obtained, radius values can be found inside which a given percentage of the particles can be expected. Confidence bounds can be placed on these radii, and the results used to estimate the suitability of the accelerator apertures.

57035 (LA-UR—79-2540) **Beam tomography in two and four dimensions.** Sander, O.R.; Minerbo, G.N.; Jameson, R.A.; Chamberlin, D.D. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790927—20). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The coming generations of high beam-power accelerators require new techniques to monitor the emittance and the shape of the beam; in particular, measurements that do not interfere with the beam itself are necessary. A new computational algorithm, MENT (Maximum ENTropy), will be presented that combines nondestructive profile measurements taken from a number of stations along the beam line with beam-dynamics calculations to compute a four-dimensional phase-space distribution. A version of MENT has been used on experimental data to reconstruct the two-dimensional transverse emittance of the Clinton P. Anderson Meson Physics Facility (LAMPF) proton beam at 100 MeV and the H^- beam at 750 keV. Wire scanners at three stations were used to get the one-dimensional profiles. Results will be compared with those gained using the destructive slit and collector method and with those gained using

MART (Multiplicative Algebraic Reconstruction Technique) on the same three profiles.

57036 (LA-UR—79-2541) **Emittance growth in linear accelerators.** Jameson, R.A.; Mills, R.S. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 7p. (CONF-790927—21). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Factors affecting emittance growth in linear-accelerator applications requiring high beam quality and low in-machine beam losses are explored. A generalized method is developed for matching the average properties of an arbitrary particle distribution to an accelerator structure in the presence of space-charge and other perturbations. The effects of the particle distribution and the accelerator parameters on the preservation of input emittance and other measures of beam behavior are investigated, to study optimum performance under carefully matched conditions, and to show the degradation of performance in the presence of mismatch, steering, and other errors. The concept of detailed matching invoking desirable correlations is discussed briefly.

57037 (LA-UR—79-2542) **High-Energy Beam Transport system.** Melson, K.E.; Farrell, J.A.; Liska, D.J. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 4p. (CONF-790927—5). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The High-Energy Beam Transport (HEBT) system for the Fusion Materials Irradiation Test (FMIT) Facility is to be installed at the Hanford Engineering Development Laboratory (HEDL) at Richland, Washington. The linear accelerator must transport a large emittance, high-current, high-power, continuous-duty deuteron beam with a large energy spread either to a lithium target or a beam stop. A periodic quadrupole and bending-magnet system provides the beam transport and focusing on target with small beam aberrations. A special rf cavity distributes the energy in the beam so that the Bragg Peak is distributed within the lithium target. Operation of the rf control system, the Energy Dispersion Cavity (EDC), and the beam transport magnets is tested on the beam stop during accelerator turn-on. Characterizing the beam will require extensions of beam diagnostic techniques and noninterceptive sensors. Provisions are being made in the facility for suspending the transport system from overhead supports using a cluster system to simplify maintenance and alignment techniques.

AUXILIARIES AND COMPONENTS

ION SOURCES

57038 (LA-UR—79-2544) **Development of a high-current deuteron injector for the FMIT Facility.** Schneider, J.D.; Rutkowski, H.L.; Meyer, E.A.; Armstrong, D.D.; Sherwood, B.A.; Catlin, L.L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-26. 5p. (CONF-790927—9). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The injector for the Fusion Materials Irradiation Test (FMIT) Facility has been designed to deliver a 100-keV, 125-mA dc deuteron beam. A prototype injector has been built to run with a H_3^+ ion beam. Two ion sources are being tested - one with magnetic-cusp geometry. The injector transport consists of a single-stage modified-Pierce extractor, a double-focusing 90° analyzing magnet, a high-power emittance scanner, steering and quadrupole focusing magnets, a mechanical beam-current modulator and a deflection type beam pulser. The performance of the prototype injector is discussed.

57039 (LA-UR—79-2553) **EBIS as an injector for heavy-ion linacs.** Hamm, R.W. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—7). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The Electron Beam Ion Source (EBIS), because of its high-charge states and pulsed operation, is ideally suited as an injector for a heavy-ion linac operating at a low duty factor. Although presently in use with conventional linacs, the low emittance and the large yield of highly charged ions in each pulse make the EBIS even more interesting as an injector for the new linac accelerating structures such as the alternating-phase-focusing (APF) structure or the radio-frequency quadrupole (RFQ) structure. These new structures could be used with an EBIS to produce a small, efficient, low-duty-cycle accelerator. Coupled to a conventional linac, the resulting accelerator could be used for heavy-ion medical therapy or nuclear physics, or it could be used as an injector for a synchrotron or storage ring.

57040 (UCID—18264) **Electronic motion in the pre-oscillation phase of a smooth bore magnetron.** Garelis, E.; Hickman, R.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Sep 1979. Contract W-7405-ENG-48. 57p. Dep. NTIS, PC A04/MF A01.

The calculation of the electronic motion in the pre-oscillation phase of a smooth bore magnetron is the problem of calculating the electronic motion in the region between two concentric cylinders with an applied radial electric field and a constant axial B/sub z/ magnetic field. The inner cylinder represents the electron emitting cathode and the outer cylinder represents the anode. The emission is assumed to be space charge limited. This results in an electronic cloud surrounding the cathode. The radial velocity of the electrons is limited by the space charge and in addition the axial magnetic field tends to curve the path of the electrons so that they return to the cathode. Consequently, the electronic orbit extends to some distance r_0 from the cathode and for values of the radius $r > r_0$ exists a charge free region. The model assumes relativistic electronic motion with self-consistent magnetic fields. The magnetic flux is assumed to be conserved; i.e., conducting cylindrical walls.

INJECTION AND EXTRACTION SYSTEMS

REFER ALSO TO CITATION(S) 57038

57041 (LA-UR—79-2455) **Injector operations at LAMPF.** Stevens, R.R. Jr.; McConnell, J.R.; Chamberlin, E.P.; Hamm, R.W.; York, R.L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—15). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The injector complex at LAMPF consists of three on-line 750-kV injectors which provide simultaneous H^+ and H^- beams for LAMPF production and an off-line 200-keV injector for ion source and beam diagnostic development studies. The present operation now entails a 500-μA/sub a/ H^+ beam accelerated simultaneously with either a 6-μA/sub a/ unpolarized or 10-nA/sub a/ polarized H^- beam. In order to obtain the low-beam spill required for the operation of the LAMPF accelerator, it has been necessary to increase the brightness of the high-intensity H^+ beam. The operating experience and development work that has been carried out on all of these injectors to improve the quality and intensity of these beams will be presented. The details of the construction of the test stand injector and the development program planned for this injector will also be outlined.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 56875, 57079

57042 (IFVE-M—24(Pt.1), pp 214-272) **LAMPF status and development.** Rosen, L. (Los Alamos Scientific Lab., NM (USA)). 1977.

From 10. international conference on high energy accelerators; Serpukhov, USSR (11 Jul 1977).

The status and basic research program of the LAMPF linac are described. LAMPF is based on a linear proton accelerator of variable energy up to 800 MeV and designed intensity of 1000 μA. The present operating current is 150 μA. Three injectors are utilized. Two beams of the H^+ and H^- are accelerated simultaneously. A polarized H^- beam was achieved. An important feature of LAMPF is the capability to provide beam to as many as 13 experiments simultaneously. Primary beam can occupy a phase space of 0.1 mr mm. The data of the basic research program which include experiments on atomic physics, nuclear chemistry, nuclear physics and particle physics are presented. Practical applications of accelerator beams and accelerator technologies are shown. The cancer treatment with negative pions up to 100 MeV energy is under way.

57043 (INIS-mf—4820, pp 107-112) **Development and study on the SPD-3 and SPD-3′ superconducting dipoles and the problem of construction of superconducting magnets for high-energy accelerators.** Alekseev, V.P.; Vasil'ev, A.A.; Galst'yan, E.A.; Greben, L.I.; Mironov, E.S.; Popokin, L.A. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The development and investigation of superconducting dipoles (SCD) with a highly uniform magnetic field in order to study processes occurring in SCD and to design prototypes of accelerating magnets are described. The magnet windings contain 8 layers of a 10 μm multistrand conductor of the NbTi alloy. The winding is placed on a stainless steel tube of 85 mm diameter. The outer diameter of the winding is 155 mm, its length being 672 mm. The nominal induction at the magnet aperture is 4 T. A uniformity of $3x10^{-4}$ was obtained over an area with a radius equal to half of that of the winding. The absolute value of the induction at the magnet centre is 0.1 T. The results of investigation into the process of magnet training are presented. The theoretical and experimental data made it possible

to solve a number of problems associated with the development of superconducting magnets for 1-2 TeV accelerating complexes.

57044 (INIS-mf—4820, pp 14O-143) **Superconducting accelerating structure of an electron linear accelerator.** Andreev, V.G.; Belugin, V.M.; Vakhmistrov, V.V.; Safonova, M.A.; Sytchenko, I.A. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The preliminary results of selection of design and manufacturing process for a superconducting accelerating structure for an electron linear accelerator in the 10 cm range are described. The structure of a copper resonator with a niobium coating consists of conducting diaphragms and collars with drift tubes. The resonator is assembled of modules and operates at the temperature of 4.2 K. The dismountable design of the resonator makes it possible to use the same modules in testing. After each type of testing one can have access to the operating surface and study its state. The use of the proposed superconducting structure with cooling by superfluid helium may ensure the operation of the electron linear accelerator in the continuous mode.

57045 (INIS-mf—4820, pp 144-147) **Superconducting electron linear accelerator.** Gurin, S.P.; Proshkin, V.I.; Rumyantsev, V.V.; Smirnov, V.L.; Sokolov, A.B.; Fokeev, V.F. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The object of the investigation is to develop a 3-5 MeV superconducting electron accelerator. The accelerator includes the following niobium superconducting elements: an accelerating structure, a chopper resonator, and a reference resonator of the master SHF generator. All the superconducting elements are designed for a frequency of 2.8 GHz. The accelerating structure consists of two independently excited resonators in the form of short-circuited sections of a diaphragmatic waveguide. The injector consists of an electron gun and a system for beam chopping and bunching. The cryogenic system ensures the cooling of the accelerating system from 4.2 to 1.85 K, the total consumption of liquid helium being up to 350 l to provide for 8 hr. operation of the accelerator.

57046 (INIS-mf—4820, pp 120-132) **Superconducting magnet systems at the Fermi Laboratory.** Kheim, D.P. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Data on the design and construction of superconducting magnets (SCM) and a helium cooling system at the Fermi Laboratory are presented. Four SCM with a field of 1.8 T and an operating current of 200 A were made and tested with the aim of replacing the conventional magnets in the ring of the energy doubler of the 200 GeV synchrotron. The magnet windings are wound on a saddle-shaped stainless steel frame. The total energy consumption was less than 10% compared with conventional magnets. The design of SCM with a maximum radial field of 4.1 T for a 3.6-m hydrogen bubble chamber is described. The magnet was operated trouble-freely for 10000 hr. It is shown that the use of SCM windings instead of conventional copper ones results in a considerable saving of power.

57047 (INIS-mf—4820, pp 133-139) **Superconducting magnets with circulation cooling.** Morpurgo, M. (European Organization for Nuclear Research, Geneva (Switzerland)). 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Questions of circulation cooling of superconducting magnets are discussed. The advantages of the circulation method of cooling are demonstrated on the examples of the "Omega" magnet at CERN and the SIN magnet compared with the immersion method. These advantages include: the possibility of developing a better mechanical magnet structure, a greater cryogenic safety of the circulation system; windings may operate in any position in space. It is shown that the use of liquid (two-phase) helium has an advantage over the use of supercritical helium for circulation by means of a pump. The problem of stabilizing superconductors with forced cooling and the technological problems associated with circulation-cooled windings are considered. The perspectiveness of circulation cooling in large-sized magnets with high magnetic fields, especially with noncylindrical windings, is demonstrated.

57048 (INIS-mf—4820, pp 101-106) **Superconducting magnetic systems with forced circulation of subcooled helium for synchrotrons.** Vasil'ev, V.L.; Dinaburg, L.B.; Zhukov, B.N. . 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The superconducting magnetic systems (SMS) of an accelerator-storage complex (ASC) for 2000 GeV and the accelerator complex Nuklotron are described. Presented are the results of calculation and mockup testing of SMS on the basis of dipole and quadrupole electromagnets, whose windings are cooled by forced circulation of helium refrigerated to 4.3 K. SMS of ASC consists of two stages of a ring magnet of 12 km long, which makes it possible to form colliding beams of protons with the energy of 800 GeV x (800-2000) GeV. The total refrigerating capacity for MSM of ASC is 45 kW at 4.2 K. The Nuklotron SMS consists of 48 dipole and 64 quadrupole magnets. The principal difference between the Nuklotron SMS and the ASC SMS consists in the absence of a void with reverse two-phase helium. The total thermal loads on the cryogenic system of Nuklotron with due regard for the circulation pump losses, are 1.8 kW at 4.2 K.

57049 (INIS-mf—4820, pp 148-150) **"Hyperon-1" superconducting magnet design.** Vetlitskii, I.A.; Belonogov, A.V.; Glukhikh, V.A. . 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

To conduct experiments on elementary particle physics, the "Giperon-1" magnet with a superconducting winding was designed. The diameter of the working area of a magnet is 1 m. The magnetic field induction at the centre of the working volume is 6 T. Two superconducting windings are spaced at 18 cm to provide for particle injection and extraction. The height of each winding is 41 cm, the minor radial size being 25 cm. The current density in the windings is 3 kA/cm^2. The total mass of the "Giperon-1" magnet, together with the cryostating system, is 176000 kg. It is shown that the use of superconducting windings will save over 2 mln roubles within 10000 hr. operation.

57050 (INIS-mf—4820, pp 97-100) **Review on superconducting charged particle accelerator studies in JINR.** Zel'dovich, A.G. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The results of investigations on the development of superconducting accelerators - Kol'tsetron and Nuklotron -are decribed. The results of cryogenic testing of separate units of both accelerators are presented. Kol'tsetron was cryostated with the aid of a helium refrigerator with a freezing capacity of 240 W. A current was repeatedly supplied into the main solenoid with a magnetic field of 2 T at the rate of 2 A/s. The maximum current density in the winding reached 1.2 x 10^4 A/cm^2. The results of testing of the source of multicharge ions "Cryon" for Nuklotron are given. During the continuous operation (40 days) of the superconducting solenoid in the "Cryon" system the current reduced from 80 to 75 A. The measured heat transfer to the liquid helium in the short-circuited regime was 0.125 W, and to the liquid nitrogen 9.9, W.

57051 (LA-UR—79-2497) **Distributed control system for the FMIT.** Johnson, J.A.; Machen, D.R.; Suyama, R.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 4p. (CONF-790927—12). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The control system for the Fusion Materials Irradiation Test (FMIT) Facility will provide the primary data acquisition, control, and interface components that integrate all of the individual FMIT systems into a functional facility. The control system consists of a distributed computer network, control consoles and instrumentation subsystems. The FMIT Facility will be started, operated and secured from a Central Control Room. All FMIT systems and experimental functions will be monitored from the Central Control Room. The data acquisition and control signals will be handled by a data communications network, which connects dual computers in the Central Control Room to the microcomputers in CAMAC crates near the various subsystems of the facility.

57052 (LA-UR—79-2498) **High-beta linac structures.** Schriber, S.O. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-790927—16). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Accelerating structures for high-beta linacs that have been and are in use are reviewed in terms of their performance. Particular emphasis is given to room-temperature structures and the disk-and-washer structure. The disk-and-washer structure has many attractive features that are discussed for pulsed high-gradient linacs, for 100% duty-cycle medium-gradient linacs and for high-current linacs requiring maximal amounts of stored energy in the electric fields available to the beam.

57053 (LA-UR—79-2500) **Developments on the RF system for the Fusion Materials Irradiation Test Facility accelerator.** Fazio, M.V.; Johnson, H.P.; Riggin, D.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—18). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The rf system for the Fusion Materials Irradiation Test (FMIT) accelerator is currently in the design phase at the Los Alamos Scientific Laboratory (LASL). The 35-MeV, 100-mA deu-

teron beam will require approximately 6 MW of rf power at 80 MHz. The EIMAC 8973 power tetrode, capable of a 600-kW cw output, has been chosen as the final amplifier tube for each of 15 amplifier chains. The final power stage of each chain is designed to perform as a linear Class B amplifier. Each low-power rf system (≦ 100W) is to be phase, amplitude, and frequency controlled to provide a drive signal for each high-power amplifier. Beam dynamics for particle acceleration and for minimal beam spill require each rf amplifier output to be phase controlled to $+\text{-}1^0$. The amplitude of the accelerating field must be held to +-1%. A varactor-tuned electronic phase shifter and a linear phase detector are under development for use in this system. To complement hardware development, analog computer simulations are being performed to optimize the closed-loop control characteristics of the system.

57054 (LA-UR—79-2514) **LAMPF operations at 500 μA.** Hagerman, D.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—19). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

LAMPF now operates reliably producing 500 μA of H^+ beam and a few μA of H^- beam or 10 nA polarized H^- beam. Beam loss in the accelerator is quite acceptable at these currents. This level of performance has been achieved through solution of a wide variety of accelerator problems and a continuous evolution of the experimental areas. The future of the facility is promising both in terms of the existing experimental programs and the opportunities for significant facility improvement projects.

57055 (LA-UR—79-2543) **Voltage breakdown testing for the radio-frequency quadrupole accelerator.** Williams, S.W.; Rodenz, G.W.; Humphry, F.J.; Potter, J.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—8). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

Designs of radio-frequency quadrupole (RFQ) accelerators with reasonable length require operation with surface fields above the limit imposed by Kilpatrick's Criterion. A cavity was designed using SUPERFISH to test the validity of this Criterion and to determine operating limits for the RFQ. The experimental setup and procedure are described, as are the data and results. A method of calibrating the test is presented.

57056 (LA-UR—79-2545) **Simultaneous beams of different energy from LAMPF.** Swain, G.R.; Hagerman, D.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—14). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The linac of the Clinton P. Anderson Meson Physics Facility (LAMPF) was designed to accelerate simultaneous H^+ and H^- beams to energies up to a maximum energy of 800 MeV. To allow more flexibility to the experimental program, it is desirable to find an operating mode such that the H^- beam may be accelerated to a lower output energy than the H^+ beam. There are two possible approaches for doing this. In one approach, the beams could time-share the rf pulses, with the radio frequency adjusted to provide the desired energy for each beam separately. In the other approach, which will be the one discussed in this paper, both beams use all of the rf pulses, and the H^- beam is kicked out of the accelerating bucket when the desired lower energy is reached. This paper discusses a possible method of separating the H^- and H^+ beams in longitudinal space (energy, phase), and summarizes dynamics calculations for various proposed schemes for kicking the H^- beam out of the bucket.

57057 (LA-UR—79-2546) **Mechanical design considerations in FMIT RFQ development.** Fuller, C.W.; Williams, S.W.; Potter, J.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—6). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The mechanical features of the several rf structures that have been made to test the theory of the radio-frequency quadrupole (RFQ) are briefly described. A 425-MHz structure, designed as a proof-of-principle (POP) test, is described in detail. Methods of coupling rf power into the structure, temperature control, tuning, and mode separation are discussed. The methods and setup of N/C machinery used to generate the critical geometry surrounding the RFQ aperture are detailed fully. Finally, the applicability of experience and methods gained from the high-frequency (425-MHz) RFQ development to the 80-MHz prototype and ultimate Fusion Materials Irradiation Test (FMIT) machine is mentioned.

57058 (LA-UR—79-2548) **LASL electron linac workshop.** Stein, W.E. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 3p. (CONF-790927—4). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

An electron linac design workshop was held at the Los Alamos Scientific Laboratory (LASL) on July 12 and 13, 1979. The primary purpose of this workshop was to address the problems of attaining high single-pulse electron currents (> 200 A) and concurrently maintaining good energy dispersion (≦ 1%) and minimal beam emittance. Present and future applications of intense single micropulses include detector-response measurements, chemical photolysis and high-energy physics experiments. For the free electron laser application, a train of many ($\sim 10^4$) intense micropulses is required. The workshop began with a brief review of existing accelerators capable of producing high current in a single micropulse. Next, future requirements and plans were discussed briefly. Most of the workshop covered presentations and discussions on electron injectors, space charge, energy compression and single-bunch beam loading.

57059 (LA-UR—79-2549) **Modular design aspects of the FMIT drift-tube linac.** Liska, D.J.; Schamaun, R.G.; Fox, W. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—13). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The Fusion Materials Irradiation Test (FMIT) Facility drift-tube linac may be subject to high levels of activation because of distributed spill of the deuteron beam. The drift-tube suspension system will use a modular design to allow repairs and alignment to be made without manned entry into the tanks. Design details are presented that show the resulting high degree of flexibility. Because the accelerator will be installed at the Hanford Engineering Development Laboratory (HEDL) at Richland, Washington, it is desirable that large prefabricated tank assemblies (15 m and 18 m long by 2.5 m diameter) be delivered to the construction site. Stress studies and vacuum sealing tests have influenced the design and these results are given. The rf power dissipation in the tank walls is 1.5 MW and requires a high-capacity cooling system. Finally, rf tuning of the tanks is complicated by the presence of girder slots and open vacuum ports.

57060 (LA-UR—79-2552) **Fusion Materials Irradiation Test (FMIT) accelerator.** Kemp, E.L.; Liska, D.J.; Machalek, M.D. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790927—22). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

An overview of the FMIT accelerator is presented. (GHT)

57061 (LA-UR—79-2554) **RF power manifold for the radio frequency quadrupole linear accelerator.** Potter, J.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-790927—11). Dep. NTIS, PC A02/MF A01.

From Linear accelerator conference; Montauk, NY, USA (10 Sep 1979).

The properties of rf power manifolds for use in a radio frequency quadrupole accelerator are discussed in the context of a coupled-circuit model. (GHT)

57062 **Beam profile monitor for secondary beams.** Krausse, G.J.; Gram, P.A.M. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **156**: No. 3, 365-367(1 Nov 1978).

The authors describe a monitor, based on a multiwire proportional chamber, that displays with mm resolution the profiles of secondary particle beams ranging in intensity from 10^8/cm²-s to 10^{10}/cm-s. The display, which appears on a standard oscilloscope, is live and quantitative; the effect of adjustments of the beam transport is immediately and continuously visible.

57063 **Relativistic heavy ion reactions.** Poskanzer, A.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *J. Phys. Soc. Jpn.;* **44**: No. , 760-771(1978).

The present status of the study of central collisions of relativistic heavy ions is presented. The phenomenology is described and evidence is presented for a source of nucleons from a central region caused by the overlapping densities of the target and projectile. Some of the current theoretical approaches are described including the nuclear fireball model. It appears that there is a quasiequilibrated region at high temperature, but the signature for the expected effects of high density is not yet clear, and therefore, experimentally, the effects of high density have not been identified.

57064 **ANL HVEM-TANDEM accelerator facilities.** Lyles, R. Jr.; Taylor, A.; Merkle, K.; Okamoto, P.; Pronko, P. (Argonne National Lab., IL). pp 76-77 of Ninth international congress on electron microscopy. Vol. 1. Ithaca, NY; Electron Microscopy Society of America (1978).

The ANL HVEM-TANDEM accelerator facilities are being developed to provide a unique combination of techniques for basic studies in the field of materials science. In addition to the methods of high voltage electron microscopy, the ion accelerator system will provide ion beam analysis and ion bombardment-implantation capability either in the HVEM or in an adjacent target area. The installation of the HVEM is completed and constitutes the first step in the development of a materials research laboratory. ANL's 1.2 MeV HVEM is an improved version of the AEI EM-7 and has a guaranteed resolution of 5 A point-to-point. The design of the microscope contains a number of unique features. These include a specially designed ion beam access flight tube, instrumentation for two independently adjustable dark field conditions, 100 to 1200 kV continuous-mode accelerating voltage selection, a negative ion trap, and an ion-pumped specimen chamber. An advanced dosimetry system and a low temperature (< 20°K) He gas cooled anticontaminator to cryogenically pump the volume adjacent to the specimen are being developed. A number of specimen stages will be available. These include a double tilt heating stage (ambient to 750°C), a double tilt cooling stage (ambient to -150°C), and an environmental cell. In addition, several special requirement stages are planned for the microscope. These include a double tilt heating and straining stage, a low temperature, side-entry He stage, and a high temperature (1600°C) heating stage. The HVEM/2-MV ion beam interface is being designed for use with both the 300 kV ion accelerator and the 2-MV tandem accelerator. A cross-sectional view of the HVEM/2-MV ion beam interface with the 300 keV ion accelerator is shown schematically.

57065 **Holifield heavy-ion research facility at Oak Ridge.** Jones, C.M. (Oak Ridge National Lab., TN (USA)). *Rev. Phys. Appl.;* **12**: No. 10, 1353-1359(Oct 1977).

A new heavy-ion accelerator facility is now under construction at the Oak Ridge National Laboratory. This paper presents a brief description of the scope and schedule of this project, a more complete discussion of the new large tandem accelerator which will be a major element of the facility, and a brief description of several studies which have been made or are in progress at Oak Ridge in preparation for operation of the tandem accelerator.

57066 **North-American MP tandem accelerators.** Wegner, H.E.; Thieberger, P. (Brookhaven National Lab., Upton, NY (USA)). *Rev. Phys. Appl.;* **12**: No. 10, 1291-1301(Oct 1977).

The North-American MP Tandem accelerators are six in number: Serial (1) Yale; (2) Minnesota; (3) Chalk river ; (4) Rochester ; and (6) and (7) Brookhaven. The current status and operating characteristics of these six tandem accelerators will be discussed in the order of their serial numbers. Upgrade and special improvements of the different machines will be reviewed and new developments since the last Electrostatic Conference will be discussed in detail. The overall operating characteristics of the different machines during the last year of operation will be compared.

STORAGE RINGS

57067 (INIS-mf—4820, pp 113-119) **Full-scale dipole magnet for the "Izabella" storage rings.** Makinturf, A.D.; Dal, P.F.; Kassner, D.; Laski, Ts.; Robins, K.; Sehmpson, U.B. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The results of testing of a full-scale dipole magnet ISA - 1 of 4. 25 m length and 12.5 cm inner diameter for "Izabella" accelerator-storage rings with a proton energy of 200 GeV are considered. The magnet was wound, assembled and tested within 4 weeks. The measured uncorrected field harmonics corresponded to an average tolerance for hte arrangement of the conductor, which was less than 50 μm. The field induction after 13 transitions to the normal state was 3.6 T instead of the calculated value of 4.0 T. The results obtained show that with slight modifications the magnet may dissipate its own stored energy trouble-freely, if the protection system becomes inoperative. The results of testing of the ISA-4 dipole magnet with the aim of studying the interaction between the winding and an iron screen are presented.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 56505, 56641

57068 (LA—7892C, pp 230-249) **NaI(Tl) detectors in intermediate energy physics.** Hughes, E.B. (Stanford Univ., CA). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The properties of Polyscin NaI(Tl) are described. The design and performance of existing modularized NaI(Tl) detectors are outlined. Candidate designs for a new series of experiments on rare μ^+ decays at the Los Alamos Meson Physics Facility are discussed.

57069 (LA-UR—79-1246) **Prospects of using large vacuum photodiodes with gas scintillation proportional counters.** Anderson, D.F. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 7p. (CONF-791037—1). Dep. NTIS, PC A02/MF A01.

From IEEE nuclear science symposium; San Francisco, CA, USA (17 Oct 1979).

The use of CsI and Cs_2Te as photocathode materials for the detection of ultraviolet light from noble gas scintillators is discussed. Calculated energy resolution for a gas scintillation proportional counter using Cs_2Te vacuum photodiodes is compared with the same counter with a photomultiplier tube. Problems which must be solved to permit fabrication of large Cs_2Te vacuum photodiodes are mentioned.

57070 (LA-UR—79-2288) **Some history of liquid scintillator development at Los Alamos.** Ott, D.G. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-790859—2). Dep. NTIS, PC A02/MF A01.

From International conference on liquid scintillation counting--recent applications and development; San Francisco, CA, USA (21 Aug 1979).

The early developments in liquid scintillation counting made at Los Alamos Scientific Laboratory are reviewed. Most of the work was under the direction of F.N. Hayes and included counter development and applications as well as synthesis and chemistry of liquid scintillators.

RADIATION DOSEMETERS

57071 **Compilation of available studies on TLD stability.** Burke, G.P. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). pp 84-93 of Proceedings of the Fifth International Conference on Luminescence Dosimetry. Sao Paulo; A. Scharmann ([nd]).

From 5. international conference on luminescence dosimetry; Sao Paulo, Brazil (14 Feb 1977).

A search of the available literature on thermoluminescence dosimetry has been carried out to identify studies on the time-temperature dependence of thermoluminescence dosimeters, including primarily the phenomenon popularly referred to as 'fading'. A bibliography is presented containing 138 references in which the results of experimental studies with commonly used phosphors are given. The phosphors included are BeO, CaF_2 doped with Dy or Mn or in the natural form, $CaSO_4$ doped with Dy, Mn, Sm, or Tm, $Li_2B_4O_7$ with Ag or Mn, and LiF:Mg, Ti. Each reference is coded to indicate the type(s) of phosphors studied.

57072 **Thermoluminecescent dosimeters (TLD's) used to monitor temperature exposure.** Romberg, G.P.; Prepejchal, W. (Argonne National Lab., Ill. (USA)). pp 387-392 of Proceedings of the Fifth International Conference on Luminescence Dosimetry. Sao Paulo; A. Scharmann ([nd]).

From 5. international conference on luminescence dosimetry; Sao Paulo, Brazil (14 Feb 1977).

A technique has been developed for using pre-irradiated TLD's to measure temperature exposure. This 'thermal dosimetry' is based on the loss of 'fade' of stored TL signal at a rate proportional to temperature such that the total accumulated fade provides a measure of the past accumulated temperature exposure.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 56667

57073 (N—79-13987) **An instrument to measure the spectrum of cosmic ray iron and other nuclei to above 100 GeV-nucleon.** Arens, J.F.; Balasubrahmanyan, V.K.; Ormes, J.F.; Siohan, F.; Schmidt, W.K.H. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Nov 1978. 42p. NTIS PC A03/MF A01.

A balloon-borne detector system for extending the study of cosmic ray composition to the energy region beyond 100 GeV/nucleon is described. The instrument incorporates an ionization calorimeter and a gas Cherenkov counter filled with freon for the determination of energies, and a charge module, consisting of scintillation and a lucite Cherenkov counter, for determining the charge of the incoming particle. The scintillators were utilized to determine the position of the incoming particle in addition to its charge. The characteristics of these detectors with respect to resolution, and the

methods employed in laboratory calibration, cross-checks with flight data and actual performance in the flights are described in detail. Monte Carlo simulation of the ionization calorimeter and comparison of the response of the calorimeter and gas Cherenkov counter for complex nuclei was used to convert the observed calorimeter signal to absolute energy in a consistent manner.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 57073

57074 Targets for heavy ion beams. Yntema, J.L. (Argonne National Lab., Ill. (USA)); Nickel, F. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). pp 206-235 of Experimental methods in heavy ion physics. Bethge, K. (ed.) (Frankfurt Univ. (Germany, F.R.). Inst. fuer Kernphysik). Berlin, Germany, F.R.; Springer (1978).

This review deals with the special difficulties of target preparation for heavy ion reactions. (WL) 891 WL.

57075 (LA—7892C, pp 222-229) **Time projection spectrometer.** Anderson, H.L. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The developmnt of the time production chamber and charge coupled devices and their applications are discussed.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 55929, 55959, 56563

57076 (BDX—613-2287) **Method of normalizing the measured scattered light from a surface defect located arbitrarily in a Gaussian intensity distribution incident on the surface.** Klingsporn, P.E. (Bendix Corp., Kansas City, MO (USA)). Aug 1979. Contract EY-76-C-04-0613. 31p. Dep. NTIS, PC A03/MF A01.

The intensity distribution of the beam from a laser operated in the TEM/sub infinity/ mode is Gaussian in a plane perpendicular to the axis of the beam. In some applications it is desirable to have a uniform intensity over a certain region in space. For example, when a Gaussian beam is incident on a smooth surface containing small isolated defects the light scattered by a defect will depend on the position of the defect relative to the center of the beam. In the past, several techniques have been devised to convert a Gaussian intensity profile into a uniform intensity over a specified region in space. In the present work a different approach is taken. A method of normalization is described which makes direct use of the Gaussian intensity distribution of the TEM/sub infinity/ mode. By this method, the amount of light scattered by a defect can be normalized to the value which would be observed if the defect were located at the center of the beam, for a defect small in size compared with the $1/e^2$ diameter of the Gaussian profile. The normalization requires that three measurements be made of the scattering by the defect for an arbitrary location of the defect relative to the center of the beam. Experimental data was obtained which verifies the theory.

57077 (LBL—9185) **Windowless and Brewster window resonant spectrophones.** Gerlach, R.; Amer, N.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 4p. (CONF-790819—7). Dep. NTIS, PC A02/MF A01.

From Topical meeting on photoacoustic spectroscopy; Ames, IA, USA (1 Aug 1979).

Problems associated with placing a spectrophone inside a laser cavity are discussed, and possible solutions are given. A spectrophone designed on the basis of these considerations is described. A single cell was built and tested with and without windows with a 54-ppM mixture of ethylene in nitrogen. Noise-equivalent absorption coefficients for Brewster window and windowless operation were estimated to be 7.5×10^{-10} cm^{-1} and 3×10^{-8} cm^{-1}, respectively. (RWR)

57078 (SAND—79-0750C) **Distributed, multi-user, data acquisition, processing, and control system for multiple aerospace simulation facilities.** Berg, D.E.; Croll, R.H. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-790926—1). Dep. NTIS, PC A02/MF A01.

From 8. IEEE international congress on instrumentation in aerospace simulation facilities; Monterey, CA, USA (24 Sep 1979).

Minicomputer-based data acquisition and control systems are widely used in aerospace simulation facilities. Many users are faced with the task of replacing older data systems or acquiring data systems for new facilities. Some of the minicomputer capabilities that are available today are discussed, and general characteristics and unique features of the particular systems acquired to replace an outdated minicomputer system are described. 5 figures, 1 table.

57079 (SLAC-PUB—2378) **Introduction to the Fastbus.** Gustavson, D.B. (Stanford Linear Accelerator Center, CA (USA)). Aug 1979. Contract EY-76-C-03-0515. 8p. (CONF-790847—8). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

The Fastbus is a modular data bus system for data acquisition and data processing. It is a multiprocessor system with multiple bus segments which operate independently but link together for passing data. It operates asynchronously to accommodate very high- and very low-speed devices over long or short paths, and uses handshake protocols for reliability. It can also operate synchronously without handshakes for transfer of data blocks at maximum speed. The goals, history, and motivation for the Fastbus are summarized briefly. The structure of the Fastbus system is described in general, and some details of its operation are introduced.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 56020

57080 Simultaneous thermal neutron decay time and porosity logging system. Smith, H.D. Jr.; Smith, M.P.; Schultz, W.E. (to Texaco Inc.). US Patent 4,152,590. 1 May 1979. Filed date 19 May 1977. 10p.

A simultaneous pulsed neutron porosity and thermal neutron capture cross section logging system is provided for radiological well logging of subsurface earth formations. A logging tool provided with a 14 MeV pulsed neutron source, an epithermal neutron detector, and a combination gamma ray and fast neutron detector is moved through a borehole. Repetitive bursts of neutrons irradiate the earth formations; and, during the bursts, the fast neutron and epithermal neutron populations are sampled. During the interval between bursts the thermal neutron capture gamma ray population is sampled in two or more time intervals. The fast and epithermal neutron population measurements are combined to provide a measurement of formation porosity phi. The capture gamma ray measurements are combined to provide a simultaneous determination of the thermal neutron capture cross section Σ.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

57081 (DOE/TIC—10181) **High explosive safety manual. Second quarterly technical progress report, January 1979-March 1979.** Albaugh, L.R.; McBride, D.A. (Hercules, Inc., Cumberland, MD (USA). Hercules Aerospace Div.). May 1979. Contract EP-78-C-01-6194. 20p. Dep. NTIS, PC A02/MF A01.

This is the second quarterly techincal report on a program to prepare a high explosive safety manual for the Department of Energy. The program is described and progress to date is presented. Current effort is directed toward finalizing the manual outline and writing manual sections.

57082 (UCID—16077-79-8) **Hard Structure Munition Project. HSM progress report No. 88, August 1-31, 1979.** Walker, F.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Sep 1979. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

A brief summary of activities on the HSM Program during the month of August is presented. The topics include the warhead effort and flight tests. (TFD)

NUCLEAR

57083 (UCRL—52806) **Enhanced coupling and decoupling of underground nuclear explosions.** Terhune, R.W.; Snell, C.M.; Rodean, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1979. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A03/MF A01.

The seismic coupling efficiency of nuclear explosions was studied in granite by means of computer calculations as a function of scaled explosion source radius. The scaled source radii were varied from 0.1 m/kt/sup 1/3/ (point source) to 20 m/kt/sup 1/3/ (representing a nearly full decoupling cavity). It was found that seismic coupling efficiency is at a maximum when the scaled source radius is approximately 2 m/kt/sup 1/3/. The primary cause of this maximum in seismic wave source strength is the effect of initial source radius on peak particle velocity and pulse duration of the outgoing elastic wave. A secondary cause is that rock vaporization (an energy sink)

does not occur for scaled source radii somewhat greater than 1 m/kt/sup 1/3/. Therefore, for scaled source radii greater than 1 m/kt/sup 1/3/, there is additional energy available for seismic wave generations. Available data for some nuclear explosions at the Nevada Test Site do not provide sufficient evidence to either support or negate the enhanced coupling that is indicated by calculations at scaled source radii of 1-2 m/kt/sup 1/3/.

CIVIL USES

57084 (UCID—18153(Rev.1)) **Novel scheme for making cheap electricity with nuclear energy.** Pettibone, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Aug 1979. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

Nuclear fuels should produce cheaper electricity than coal, considering their high specific energy and low cost. To exploit these properties, the scheme proposed here replaces the expensive reactor/steam-turbine system with an engine in which the expansion of a gas heated by a nuclear explosion raises a mass of liquid, thereby producing stored hydraulic energy. This energy could be converted to electricity by hydroelectric generation with water as the working fluid or by magnetohydrodynamic (MHD) generation with molten metal. A rough cost analysis suggests the hydroelectric system could reduce the present cost of electricity by two-thirds, and the MHD system by even more. Such cheap power would make feasible large-scale electrolysis to produce hydrogen and other fuels and chemical raw materials.

EXPLOSION DETECTION

REFER ALSO TO CITATION(S) 57197

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 57096, 57102, 57103, 57200

57085 (AD-A—061684) **Environmental and Ecology Branch progress report, 1974 through 1976. Volume II. Final report, 1 January 1974-31 December 1976.** Adams, A.P.; Choules, G.L.; Crane, G.T.; Faulkner, F.; Garbett, M. (Army Test and Evaluation Command, Dugway, UT (USA)). Jun 1978. 46p. NTIS PC A03/MF A01.

In accordance with the National Environmental Policy Act (NEPA), all projects at Dugway Proving Ground (DPG) are evaluated for their potential for causing adverse environmental impact. Environmental studies for other U.S. Army installations include baseline ecological surveys, demography of jackrabbits and selected rodents. These programs have provided population and toxicological baseline data on wildlife. Investigations have been made of hazards associated with bacterial aerosols generated by cooling towers using biocontaminated wastewater. The organic nitrogen wastes generated by manufacture of Army explosives have been studied with regard to aeration rates, residence times, nutrient requirements and other physical and biological factors. A handbook for evaluating ecological effects of pollution on DARCOM installations has been prepared for the Pollution Abatement and Environmental Control Technical Lead Laboratory. Consultation services concerning environmental and epidemiological problems and mosquito control were provided to the Facilities Engineering Directorate of U.S. Army, Yuma Proving Ground, Arizona. (Author)

57086 **Nonlinear interaction model between land biota and the atmosphere.** Kohlmaier, G.H. (Istitut fuer Physikalische Chemie, Frankfurt, Germany); Fischbach, U.; Kratz, G.; Sire, E.O. pp 111-119 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Assuming the most probable values for inventories and fluxes of the global carbon cycle it was possible to reproduce past and present values of atmospheric carbon by adding to the relatively well-known fossil fuel carbon flux the current man-made biogenic flux of about 2 to 4 X 10^9 t C/a. Larger biogenic carbon fluxes have a very sensitive effect on the stability of the atmosphere; for this reason it is concluded that the biosphere must be conserved as much as possible. Under the condition of an intact biosphere adopting a 3.3% growth in fossil fuel use annually, the increase of CO_2 is less than predicted on the average (in 2025, between 850 and 900 x 10^9 t C).

57087 **Mathematical treatment of box models for the CO_2-cycle of the earth.** Avenhaus, R.; Fenyi, S.; Frick, H. (Kernforshungszentrum, Karlsruhe, Germany). pp 121-127 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The CO_2-cycle of the earth is described by a system of coupled first order differential equations. Equilibrium states of the undisturbed cycle and the dynamic behavior of the disturbed cycle are analyzed. The results are illustrated with some numerical calculations.

57088 **Introduction to the climate/environment aspects of CO_2 (a pessimistic view).** Williams, J. (International Inst. for Applied Systems Analysis, Laxenburg, Austria). pp 131-139 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The problems that arise when estimates are made of the effect on climate of increasing the atmospheric CO_2 concentration. The climatee system is highly ccomplex and nonlinear and the understanding of (and ability to predict) climatic variations is poor. Observational stdies and the use of models have helped in understanding some of the processes and mechanisms dof climatic variations, but predictions still cannot be made.

57089 **Effects of doubling the CO_2 concentration on radiative-convective equilibrium.** Rowntree, P.R.; Walker, J. (Meteorological Office, Bracknell, England). pp 181-191 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

A single column radiative-convective equilibrium model was used to investigate the dependence of the effects of doubling CO_2 on the assumptions made for the temperature and humidity structure. It is found that, relative to a convective parameterization which generates a moist adiabatic lapse rate, a convective adjustment to a fixed lapse rate exaggerates the effect of doubling CO_2 for surface temperatures above about 280°K, but makes little difference at lower temperatures. The results are quite sensitive to the assumptions made for relative humidity, indicating the need for a realistic parameterization of convection in CO_2 experiments.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56749, 57086, 57087, 57088, 57089

57090 (IVL-B—484) **Long and short distance transport of SO_2 and NO/sub x/.** Grennfelt, P. (Swedish Water and Air Pollution Research Lab., Stockholm). Jan 1979. 18p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

On the basis of air pollution measurements in ambient air, the relationship between locally emitted (and formed) compounds in Gothenburg and long-distance transported pollutants is discussed. The components involved are SO_2, SO_2^{-4}, NO, NO_2 and NO^-_3 (gaseous and particle-bound). The results show that for most of the compounds (except for NO and, to some extent, NO_2) the contribution from distant sources is not negligible. For SO_2, it is 20% and for SO^{2-}_4 it is about 85%. For NO^-_3, the measurements indicate that the local contribution is entirely negligible.

57091 (PB—288905) **Compilation of air pollutant emission factors. Third edition (including supplements 1-7). Supplement No. 8.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). May 1978. 107p. NTIS PC A06/MF A01.

In this supplement for compilation of Air Pollutant Emission Factors (AP-42), revised and updated emissions data are presented for wood stoves, refuse incineration, open burning, off-highway stationary sources, primary copper smelting, secondary copper smelting and alloying, cotton ginning, ammonium nitrate fertilizer manufacturing, asphaltic concrete plants, asphalt roofing manufacturing, glass manufacturing, petroleum refining, unpaved roads, and paved roads. The contents cover: Wood stoves, refuse incineration, open burning, internal combustion engine sources; notice, off-highway stationary sources, cotton ginning, ammonium nitrate fertilizers, primary copper smelting, secondary copper smelting and alloying, asphaltic concrete plants, asphalt roofing, glass manufacturing, petroleum refining, unpaved roads (dirt and gravel), and paved roads.

57092 (PB—289271) **Chalk Point Cooling Tower Project: cooling tower effects on crops and soils. Post operational report No. 3. Final report, 1 July 1977-30 June 1978.** Mulchi, C.L.; Wolf, D.C.; Arm-

bruster, J.A. (Maryland Univ., College Park (USA). Water Resources Research Center). Jul 1978. 107p. NTIS PC A06/MF A01.

This report contains a summary of dustfall, rainfall, crops and soils information obtained from a network of 12 research sites which are located within a 9.6 km radius of an operational natural draft cooling tower at Chalk Point, Md. during the period 4/77 - 4/78. Results from previous years which included two years of preoperational (4/73 - 4/75) and two years of postoperational (5/75 - 3/77) data were compared with the present information. This report also contains summaries of agronomic and chemical data obtained from experiments involving the effects of soil and foliar applied salts on tobacco, corn, and soybeans in plots located at the University of Maryland's Tobacco Experimental Farm.

57093 (RLO—2227-T27-5) **Wet and dry deposition and resuspension of atmospheric trace constituents: current knowledge and research needs.** Slinn, W.G.N. (Oregon State Univ., Corvallis (USA). Air Resources Center). Oct 1978. Contract EY-76-S-06-2227-027. 31p. (CONF-7810124—1). Dep. NTIS, PC A03/MF A01.

From NSF atomospheric chemistry workshop; Boulder, CO, USA (16 Oct 1978).

In preparation for the Sources and Sinks session at the NSF Atmospheric Chemistry Workshop, 16-20 October 1978, Boulder, CO, a brief review is given of current knowledge in the fields of wet and dry removal processes and resuspension. Research needs are mentioned; these include the need for additional knowledge about wet and dry removal of particles in the size range between about 0.1 and 1.0 μm. Instead of suggesting priorities for additional and/or new research, the author suggests that NSF continue to operate using their unsolicited proposal/peer review system which has operated successfully in the past. In addition, the author cautions the NSF against stimulating additional instabilities in American science.

57094 (UCRL-Trans—11494) **Pollution transfers at various scales of time and distance.** Doury, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). Jun 1979. Translation of DSN report No. 241, February 1979. 56p. Dep. NTIS, PC A04/MF A01.

It is often assumed that problems involving the transfer of pollution by the atmosphere call for specific treatments which differ according to the circumstances, and particularly according to the considered scales of time and distance. The differences between the treatments most commonly used at present, and their similarities, their complementary features, and their association with a single body of doctrine are described. The scales include: the aerological scale (up to a few tens of km); the intermediate scale or mesoscale (a few tens to a few hundreds of km); and, the synoptic and planetary scale (beyond a few hundred km). To be complete, it is necessary to add to this classification the cases of long transfer times in a restricted region of space (low winds, urban pollution). Whatever the scale of the problem to be solved, the treatment itself generally comprises three basic steps: the primitive equations of conservation of mass and momentum, associated with equations of equilibrium and state; the numerical, analytical, or mixed solutions of the primitive equations; and, the relations between the parameters of the medium (meteorological) and the coefficients of the solutions (models). For each of these steps it is convenient to distinguish: between momentum transfers of the carrier fluid and pollutant transfers by the carrier fluid. After a review of the methods commonly used, illustrated by concrete examples, it is concluded that in the field of atmospheric pollution an apparent diversity and disorder actually hide a rather satisfactory situation and that, for most of the problems posed, there exist acceptable practical solutions which are also coherent.

57095 Temporal and spatial patterns of carbon allocation in the canopy of white oak. McLaughlin, S.B.; McConathy, R.K. (Oak Ridge National Lab., TN). *Can. J. Bot.;* **57**: No. 13, 1407-1413(1979).

The fate pf photoassimilated ^{14}C was followed by measuring ^{14}C incorporation into leaf and branch tissues ($\leq$ 5 years old) of two forest-grown white oak trees. Fate of ^{14}C-labelled photosynthate was examined 7 days after $^{14}CO_2$ uptake on five dates (April-October) during the growing season. Both upper and lower canopy positions were sampled. Incorporation of ^{14}C into foliage was significant throughout the growing season. It ranged from 95% of the total ^{14}C in April to 50% in October. Incorporation of ^{14}C-labelled photosynthate into the canopy was highest in June and averaged 33% of gross photosynthetic production over the entire growing season. Higher retention of photosynthate in branches versus leaves was noted in the upper canopy than in the lower canopy during the middle and late growing season. Activity levels in tissues indicated that within-canopy sink strength was in the order acorns approx. equal to buds > leaves > branches. Translocation of initial ^{14}C-labelled photosynthate from both leaves and branches was calculated based on ^{14}C retention and estimated respiratory losses of leaf and branch tissues. These calculations indicate that leaves were still importing significant amounts of photosynthate in April when expansion was two-thirds complete. Translocation of ^{14}C from the canopy during the remaining growing season amounted to 25 to 45% of gross photosynthesis. Data indicate that seasonal demands of growth and maintenance of the forest canopy constitute a substantial sink for photosynthate allocation by white oak.

57096 Carbon dioxide, climate and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978). 342p. (CONF-780287—).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Conference papers are divided into the following categories: the carbon cycle; the impact on climate and environment of increasing atmospheric CO_2 concentrations; and the interaction between energy strategies and the CO_2 question. Papers in scope for ERA/EDB were abstracted and indexed individually. (JGB)

57097 Preliminary evaluation of past CO_2 increase as derived from ^{13}C measurements in tree rings. Freyer, H.D. (Kernforschungsanlage, Juelich, Germany). pp 69-77 of Carbon dioxide, climate and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Carbon-13 data (in the cellulose fraction) from different trees of the northern hemisphere are presented, covering the last 150 years. These data were taken for preliminary model evaluation of the past atmospheric CO_2 increase and total anthropogenic CO_2 production since industrialization. Preindustrial atmospheric CO_2 concentration was 295 +- 1 ppM. The biospheric CO_2 source from the beginning of industrialization to the middle of this century has been larger than the fossil one. The ratio of the cumulative input of fossil to nonfossil CO_2 into the atmosphere from the beginning of industrialization up to 1974 is 2:1 (136 x 10^9 t C of fossil and 70 x 10^9 t C of nonfossil CO_2). The present input rates are 5 x 10^9 t C/a of fossil and 3 +- 2 x 10^9 t C/a of nonfossil CO_2, based on an airborne fraction of (58 +- 14)% and 36% for fossil and total CO_2 input, respectively. (JGB)

57098 Model responses of the atmospheric CO_2 input. Siegenthaler, U.; Heimann, M.; Oeschger, H. (Univ., Bern, Switzerland). pp 79-87 of Carbon dioxide, climate and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The responses of the atmospheric CO_2 and ^{13}C levels were computed for a combined fossil and biogenic input by means of a box-diffusion model. In order to demonstrate the effect of different biospheric input histories (in addition to the fossil input), model responses for the following cases are presented: zero biogenic input, only fossil CO_2; ' .ogenic flux always equal to one half and fossil flux, i.e., both increase in an approximately exponential way; biogenic production rate according to a Gaussian curve, with maximum in 1890 and width $\delta = 20$ years, cumulative input from biota equal to 65 x 10^9 t of C, or one half the fossil input until 1974. After 1950, the biogenic production is essentially zero for case 3, which has been included for analyzing the effect of a past input on the present situation. For all three cases, no fertilizing effect of the additional CO_2 is assumed (biota growth factor $\epsilon = 0$). (JGB)

57099 Source functions for CO_2 in the atmosphere. Zimen, K.E. (Hahn-Meitner Inst. fuer Kernforschung, Berlin, Germany). pp 89-102 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Input of CO_2 into the atmosphere from fossil fuels and changing biomass is evaluated. It is necessary to find a new sink or sinks for CO_2. Perhaps one of these sinks could be the carbonates on land. The sediments on the continents constitute roughly 5 x 10^8 km^3. The fraction of limestone in the sediments is about 8%, but with regard to the fraction on the surface exposed to the air it may be about 29%. If the 5 x 10^8 km^3 sediments are distributed evenly all over the land area of 136 x 10^6 km^2, a layer of 3.7 km is formed. It is assumed that on the average a layer of 1 m is in contact with the CO_2 in the air. Then, with a density of $CaCO_3$ of 2.7 t/m^3, the amount of limestone in this surface layer is (0.29 x 5 x 10^{17} m^3 x 1 m/3700 m) x (2.7 x 10^6 g/m^3) $\simeq$ 1 x 10^{20} g = 1 x 10^{18} mols. Thus the carbon reservoir in contact with the atmosphere is about 2 orders of magnitude larger than the carbon reservoirs in the atmosphere, the biosphere, and the mixed surface sea.

57100 Vegetation and CO_2 changes. Lieth, H. (Univ. Osnabrueck, Germany). pp 103-109 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The potential of global vegetation as a source of CO_2 concentration in the atmosphere is discussed. A model was constructed fo

gross primary productivity, net primary productivity, and dark respiration. Results are tabulated. (JGB)

57101 Potential consequences of increasing CO_2 levels in the atmosphere. Bach, W. (Center for Applied Climatology and Environmental Studies, Muenster, Germany). pp 141-167 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The potential consequences for agricultural productivity and world food supply of increasing atmospheric CO_2 levels and the resulting climate variations are reviewed. Above all, increasing CO_2 raises the surface air temperature and changes the distribution of precipitation. The combined effects of these elements may already be adversely influencing food production in some regions. There is a high probability that the adverse effect will become more frequent and more widespread as the CO_2 concentration in the atmosphere continues to increase over the next decades.

57102 Cryospheric responses to a global temperature increase. Barry, R.G. (Univ. of Colorado, Boulder). pp 169-180 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The likely nature of possible changes in the cryosphere that would follow a global warming induced by an increase in the atmospheric content of CO_2 is discussed. It is concluded that warming effects would be negligible on the century time-scale for major ice sheets and ground ice. Changes in seasonal snowfall in high latitude or in Arctic pack ice may also be minimal for an initial doubling of CO_2. Any increase in winter snowfall would probably be offset by increased summer melt. For the pack ice, it is possible that greater melt, by leading to more pools and open water, would increase the stratus cover and reduce the solar radiation input. The critical factor here sould be an increase in meridional advection in the atmosphere and the ocean. In both cases, however, negative feedbacks are a possibility for a limited warming.

57103 Global temperature changes: relative importance of different parameters as calculated with a radiative-convective model. Reck, R.A. (General Motors Corp., Warren, MI). pp 193-200 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

A radiative-convective model was used to calculate the response of the calculated temperature profile to a variety of changes in atmospheric constituents, CO_2, H_2O, O_3, and airborne particles as well as to changes in surface albedo and Rayleigh scattering. In the troposphere the response decreases with altitude at about the same rate as the temperature, reaching 80% of its surface value at 8.3 km (336 mb). In the stratosphere the response increases as the calculated temperature increases. When airborne particles are present the response to other parameters is reduced. It is concluded that these results illustrate the difficult nature of attempting to make predictions of the climatic consequences due to changes in any one global parameter since many are of significant size.

57104 Factors of the greenhouse effect of the atmosphere and their influence on climate. Kondratyev, K.Ya.; Bunakova, A.M. (Leningrad Univ., USSR). pp 201-207 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The contribution of freons and other minor gaseous constituents to the atmospheric greenhouse effect is considered, and possible relevant climatic consequences are discussed. Previous studies indicate that atmospheric pollution caused by freons and by a change in the radiation balance of the earth-atmosphere system may influence climate more than other anthropogenic factors such as an increase in the concentration of CO_2 and aerosols. It is concluded that the role of various atmospheric consituents should be taken into account in planning a system for monitoring parameters important to climatic changes. (JGB)

57105 Diffusion and transfer of climatically relevant gases close to the earth's surface. Djolov, G.D. (State Council of Bulgaria, Dongukov). pp 209-215 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

When the transfer and diffusion of gases close to the earth's surface are examined, the way in which they interact with different types of underlying surfaces has to be properly recorded. The molecular sublayer must also be taken into account. It is concluded that the study should be extended to permit calculation of the turnover time of different climatically relevant gases through the molecular sublayer. More extensive data are needed for the specification of the universal function for the molecular resistance and the interaction constant β for n different gases.

57106 Climatic limits to growth: how soon; how serious. Schneider, S.H. (National Center for Atmospheric Research, Boulder, CO). pp 219-225 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The effects of an increase in atmospheric CO_2, NO/sub x/, and other trace gases with strong infrared absorptions on global climate are reviewed. Several steps to minimize society's vulnerability to such changes are suggested. They include: learn the range of possibilities so that facts and values can be more easily disentangled; focus current energy debate on growth rate issues, particularly for Third World countries; conserve energy and develop viable solar or other renewable resources; and, begin now to minimize our economic dependence on energy growth. It is concluded that weighing the risks of possible climatic changes against the benefits of continued and increased fossil fuel consumption is a process long overdue. (JGB)

57107 Effects of different energy strategies on the atmospheric CO_2 concentration and climate. Williams, J. (International Inst. for Applied Systems Analysis, Laxenburg, Austria). pp 239-247 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

In order to assess the future atmospheric CO_2 concentration and its implications, three models are required. An energy model is used to estimate the future use of fossil fuels, and thus to estimate the input of fossil fuel CO_2 into the atmosphere. The amount of the fossil fuel CO_2 that remains in the atmosphere can then be given by a model of the carbon cycle, which considers the reservoirs of carbon and the transfers between them. The effects of the atmospheric CO_2 concentration on climate can then be assessed using a climate model. To the results of each of these models must be attached an uncertainty such that the future use of fossil fuels and the implications thereof cannot be predicted. The model results can only be used at the present time to assess the magnitude of the problem. The results of three scenarios are discussed; limitations of the results are pointed out.

57108 Fossil fuel utilization policy assessment and CO_2 induced climatic change. Laurmann, J.A. (Stanford Univ., CA). pp 253-261 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

In order to assess the policy implications of the growing acceptance of the reality of this CO_2 threat to the environment, a judgment is required as to the likelihood not only of the occurrence of the environmental insult but also of governmental actions that might be taken to avoid it. In developing the arguments presented, it was found that considerations are dominated by uncertainties, the sources of which range from the strictly scientific to the geopolitical. A summary of an attempt to quantify the former is presented, thereby leading to recommendations for steps needed to prepare for the succeeding evaluation of the interregional social and political problems that will have to be addressed if global remedial measures are indeed found to be necessary. The analysis is formulated in terms of projections that assume continuity of present energy resource usages. The importance of the various sources of prediction uncertainty need to be reconsidered when evaluating strategies of amended fossil fuel use.

57109 Atmospheric CO_2 consequences of heavy dependence on coal. Rotty, R.M. (Oak Ridge Associated Universities, Inc., TN). pp 263-273 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

The energy demands of various segments of the world as they are now and could be in 50 years are assessed. Annual fossil fuel CO_2 releases were calculated to contain 23×10^9 t of carbon for this period. It is concluded that the problem of avoiding a CO_2-triggered climate change becomes that of providing fuel for the developing countries to assure their progress without heavy dependence on fossil fuels. It is recommended that the following areas of inquiry receive serious consideration: rate of fossil fuel use; distribution of CO_2 produced from fossil fuel combustion and from other anthropogenic sources among the several reservoirs in the carbon cycle; effects of concentration of CO_2 on climate; and, global response of a CO_2-induced climate change. (JGB)

57110 Standard setting for carbon dioxide. Hoepfinger, E. (International Inst. for Applied Systems Analysis, Laxenburg, Austria). pp 279-282 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Since the effects of increased shares of CO_2 in the atmosphere are not well known, there exist rather contradictory conjectures. A continuous increase of CO_2 in the atmosphere from fossil fuel combustion beyond an unknown critical value will lead to irreversible large-scale changes in the earth's climate. A model is presented for the decision problem, taking into account different interest groups. The problem of how to determine and adapt an emission standaard for CO_2 is treated within the framework of a three-person infinite-stage game; the players area called regulator, producer, and impactee.

57111 Effect of chemical variability of individual fly ash particles on cell exposure. Hayes, T.L. (Univ. of California, Berkeley); Pawley, J.B.; Fisher, G.L. pp 239-244 of Scanning Electron Microscopy/1978. Vol. I. Hoffman Estates, IL; Scanning Electron Microscopy, Inc. (1978).

Individual particles of fly ash pollutant formed by coal burning power plants are extremely heterogeneous with respect to matrix element composition. Many elements occur at high concentration in certain particles rather than being uniformly distributed at lower concentration among many particles. When fly ash particles interact with the biological organism a given cell is exposed to a small number of particles and the great variability in composition suggests that cell exposure will vary widely depending on the particular particles associated with that cell. Analysis techniques which give values for elemental composition based on the average of many particles do not reveal possible variation in composition from particle to particle. Single particle, single cell studies by scanning electron microscopy (SEM) with energy dispersive x-ray analysis provide data on single particle morphology and elemental composition. The heterogeneity of matrix elemental composition between individual particles is evident even with the limited number of particles analyzed to date. Heterogeneity (large variations in matrix elements) was also pronounced in samples collected on plant surfaces in an urban environment. The analysis of matrix elements (1 to 50% concentration) showed wide variation between the various particle types collected on this surface. Individual particles of fly ash could be mapped on and within pulmonary alveolar macrophage cells. The exposure level of single cells to foreign elements existing at high concentration in single particles can be several times the exposure level estimated on the basis of a fairly narrow spread of particle composition around the mean value determined by multiparticle methods.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56094

57112 Geochemistry of atmospheric radon and radon products. Turekian, K.K.; Nozaki, Y.; Benninger, L.K. (Yale Univ., New Haven, CT). *Annu. Rev. Earth Planet. Sci.;* **5**: 227-255(1977).

The following topics are discussed: measurement of the radon-222 flux to the atmosphere; measurement of the lead-210 atmospheric flux; and the mean residence time of aerosols. A total global model is proposed for radon-222 and its daughters.

REGULATIONS

REFER ALSO TO CITATION(S) 56750, 56751, 56775, 56776, 57110

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

57113 (EPRI-EL—1112) **New methods and chemicals to control regrowth in trees. Interim report. Research Project 214.** Roberts, B.R.; Brown, G.K.; Wilson, C.L. (Science and Education Administration, Delaware, OH (USA). Nursery Crops Research Lab.). Jul 1979. 125p. Dep. NTIS, PC A06/MF A01.

A study was made of new methods and chemicals for controlling growth in trees. As part of this research program a portable, air-powered equipment system was developed for injecting low volumes of concentrated aqueous chemical solutions into trees for sprout regrowth control. The system has been tested successfully on several tree species in the field. Using 1- and 2-year old containerized seedlings in the greenhouse, a screening procedure was developed whereby numerous growth regulating chemicals were tested for their effectiveness in controlling regrowth on 23 different tree species. The most consistently effective chemicals were daminozide, maleic hydrazide, and dikegulac. At appropriate concentrations, these chemicals controlled sprout regrowth in most species tested without causing unacceptable symptoms of phytotoxicity. Laboratory studies on the translocation and metabolic behavior of radiolabelled daminozide and maleic hydrazide conducted with young seedlings of American elm, red oak, silver maple, and American sycamore showed that both chemicals are rapidly transported to all parts of the plant. Whereas most of the radioactivity is extractable, a significant portion (20%) is apparently bound in various plant tissue, particularly in the stem. Metabolism studies show that in silver maple and American sycamore, maleic hydrazide is converted to a sugar conjugate of maleic hydrazide. No detectable metabolites of daminozide were found in any of the species studied. Approximately 1 month after treatment, up to 18% of the radiolabelled maleic hydrazide was exuded from the roots of silver maple, sycamore and elm, whereas no such exudation was detected from the roots of red oak.

57114 Nutrient flux in litter and surface soil after nitrogen and phosphorus fertilization. Kelly, J.M.; Henderson, G.S. (Tennessee Valley Authority, Muscle Shoals, AL). *Soil Sci. Soc. Am. J.;* **42**: No. 6, 963-966(Nov 1978).

The effect of urea and concentrated superphosphate additions on the movement of N, P, K, and Ca from the litter and top 10 cm of the mineral soil via the soil solution was evaluated in an upland oak forest using tension lysimeters. The range in total flux values for each element over the study period were: N 24.8 to 1145.3; P 2.0 to 633.3; Ca 70.6 to 553.1; and K 49.5 to 94.0 kg/ha in response to various combinations of N and P fertilizer addition at levels of 0, 550, and 1100 kg/ha N and 0, 275, and 550 kg/ha P. Nitrogen fertilizer addition significantly increased the flux of N and K while reducing the flux of P and Ca. Phosphorus fertilizer addition significantly increased N, P, Ca, and K fluxes. Solubilization of organic matter and the formation of insoluble calcium ammonium phosphate were important processes regulating the flux of N, P, Ca, and K.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56749, 57092, 57124

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56138

57115 (CONF-790923—5) **Analysis of soil samples from OMRE decommissioning project.** Simpson, O.D.; Chapin, J.A.; Hine, R.E.; Mandler, J.W.; Orme, M.P.; Soli, G.A. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 14p. Dep. NTIS, PC A02/MF A01.

From Decontamination and decommissioning of nuclear facilities conference; Sun Valley, ID, USA (16 Sep 1979).

In order to establish that the present Organic Moderated Reactor Experiment (OMRE) site does not exceed the criteria for radioactive contamination, samples obtained from the remainder of the facility that was not removed such as soil, concrete pads, various structural materials, and the leach pond area were analyzed to determine their radioactive content. The results of the analyses performed on soil samples are presented. Results of this study indicate that the activity at the OMRE decommissioned area is confined to localized areas (i.e., the leach pond area and reactor area). Comparisons of radionuclide concentrations measured in soil taken from the lip of the leach pond with concentrations in soil obtained outside the Idaho National Engineering Laboratory (INEL) site boundaries indicate that the concentration in the soil at the edge of the leach pond is at background levels. The vertical augering technique was determined to be the best approach for obtaining shallow soil samples at the INEL. Selection of this technique was based on ease of operation and analytical results. Less area is disturbed per sample than with the horizontal trenching and coring techniques. The radionuclide analysis of the samples shows the existence of a few regions in the reactor and leach pond areas that were still above INEL release criteria. These regions have been or are being further decontaminated.

SOIL

REFER ALSO TO CITATION(S) 56129, 56131, 56135, 56136, 56137, 56141, 56143

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 55988, 56756

57116 Energy facility siting issues in New Jersey's coastal zone: a staff working paper. Busemann, H. Trenton, NJ; New Jersey Department of Environmental Protection (1977). 102p. (NP—23954).

The requirement of the New Jersey Coastal Area Facility Review Act and the Federal Coastal Zone Management Act that energy facility siting be included in any coastal planning has mandated that the New Jersey Office of Coastal Zone Management (NJOCZM) address the siting of energy facilities in the coastal zone. The issues facing coastal energy planners are reviewed. Issues addressed include nuclear power, Outer Continental Shelf oil and gas exploration and development, deepwater ports, liquefied natural gas, and the more general issues of energy conservation and the siting of energy facilities. The report includes an overview of how energy is used and produced today in New Jersey. Some principles that will guide the NJOCZM in developing energy facility siting policies within the coastal zone are set forth. The report is intended as a working document to provoke discussion by energy users and energy producers, by local, state, and federal officials and agencies, by private interests and by the public. It is hoped that these discussions will lead to a further refinement of the issues, from which responsible and coherent coastal energy facility siting policies will emerge which can be incorporated into New Jersey's coastal management strategy.

REGULATIONS

REFER ALSO TO CITATION(S) 56750, 56751, 56775, 56776

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

57117 (KBS-TR—91) **Short-time variations of the ground water level.** Nilsson, Lars Y. (Kaernbraenslesaekerhet, Stockholm (Sweden)). Sep 1977. 34p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

Investigations have demonstrated that the ground water level of aquifers in the Swedish bedrock shows shorttime variations without changing their water content. The ground water level is among other things affected by regular tidal movements occuring in the "solid" crust of the earth variations in the atmospheric pressure strong earthquakes occuring in different parts of the world These effects proves that the system of fissures in the bedrock are not stable and that the ground water flow is influenced by both water- and airfilled fissures.

57118 Consumer regulation of nutrient cycling. Kitchell, J.F. (Univ. of Wisconsin, Madison); O'Neill, R.V.; Webb, D.; Gallepp, G.W.; Bartell, S.M.; Koonce, J.F.; Ausmus, B.S. *Bioscience;* **29**: No. 1, 28-34(Jan 1979).

Nutrient-cycling rates in ecosystems may be altered by translocation and transformation that result from the consumption process and/or the behavior of consumer organisms. Translocation by mobile consumers redistributes nutrients within and between subunits of the ecosystem. Migration of zooplankton and fishes carries nutrients across water-mass boundaries or retards net flux by sedimentation. Bioturbation of sediments and mixing of soil horizons by invertebrates similarly redistribute nutrients across system strata, facilitating utilization by primary producers. Transformation of particle size distribution alters rates of nutrient cycling in proportion to changes in surface/volume relationships. Through selective predation and comminution, consumers regulate rates of nutrient cycling. Nutrient pools comprised of large biomass units (e.g., tree boles, soil litter, lake zooplankton) may be transformed to smaller units, resulting in accelerated nutrient-cycling processes. Small units may be aggregated, for example, as macroarthropod feces or fish biomass, resulting in conservation of nutrients. (Where coevolution of plants and animals has occurred (Owen and Wiegert 1976, Porter 1977), direct assessment through experimentation is not possible. As a result, it is difficult to determine the net in situ effect of a given consumer population on total system function. The information reviewed, however, proves that consumers substantially influence nutrient-cycling rates through physical processes, which are poorly represented by viewing consumers merely as components of energy-flow patterns.

57119 Gulf of Maine intermediate water. Hopkins, T.S. (Brookhaven National Lab., Upton, NY); Garfield, N. III. *J. Mar. Res.;* **37**: No. 1, 103-139(1979).

The thermohaline dynamics of the Gulf of Maine are analyzed from the two year, eight cruise, data set of Colton, Marak, Nickerson, and Stoddard (1968). Six water masses are described: the Maine Surface Water, Maine Intermediate Water, and the Maine Bottom Water as interior water masses; and the Scotian Shelf Water, the Slope Water, and the Georges Bank Water as exterior water masses. Particular attention is given to the formation and disposition of the Maine Intermediate Water. Salt balance, T-S volume, and T-S drift analyses are used to provide transport and mixing estimates for the year 1966. The Slope Water entered at depth through the Northeast Channel at a rate of 2600 km^3/yr; while the Scotian Shelf Water entered the surface and intermediate layers, mostly during winter intrusions, at a rate of 5200 km^3/yr. The surface and intermediate layers exported a total of 7900 km^3/yr in a 3:5 ratio, respectively. The Maine Intermediate Water tends to collect over the Wilkinson Basin during the stratified season, to exit via the Great South Channel during early spring, and to exit via the Northeast Channel during spring and summer. Comparisons are made between the estimated winter heat loss of 280 Ly/d and the observed heat losses of 230 Ly/d (surface layers) and 360 Ly/d (surface and intermediate layers). A limit for the Scotian Shelf Water contribution is about ~70 Ly/d. It is concluded that the Maine Intermediate Water is produced locally and that it is exported in significant quantities.

57120 Thermal effects. Talmage, S.S.; Coutant, C.C. (Oak Ridge National Lab., TN). *J. Water Pollut. Control Fed.;* **1514**-1553(Jun 1978).

A literature review of temperature effects on the aquatic environment is presented. The literature reviewed covers marine ecosystems in rivers, lakes, cooling ponds, estuaries, and marine sites. There are 8 tables summarizing the effects of temperature on reproduction, embryonic development, larval development, distribution, tolerance, oxygen metabolism, growth, and interaction of other stresses on a wide variety of aquatic organisms. There are 400 references cited.

57121 Long-term wind variability in the tropical Pacific, its possible causes and effects. Reiter, E.R. (Colorado State Univ., Fort Collins). *Mon. Weather Rev.;* **106**: No. 3, 324-330(Mar 1978).

It is shown that long-term trends in the meridional components of the trade wind circulations in both hemispheres over the Pacific are highly correlated with the precipitation falling in the intertropical convergence zone (ITCZ) over that region. The trends in the trade wind regime, on the one hand, seem to be caused by extratropical sea surface temperature (SST) anomalies in the North Pacific which influence atmospheric meridional temperature and pressure gradients. On the other hand, the release of latent heat in the ITCZ provides a self-enforcing feedback for the trade winds. A study of the recurrence frequency of precipitation surges over the Line Islands suggests the presence of three epochs (1911 to 1928, 1929 to 1962, 1963 to present) during which the Hadley cell circulation and attendant meteorological and oceanographic features showed different characteristics.

57122 Estimated, in situ, rates of egg production for the copepod Centropages typicus (Kroyer) in the New York Bight. Dagg, M. (Brookhaven National Lab., Upton, NY). *J. Exp. Mar. Biol. Ecol.;* **34**: 183-196(1978).

Centropages typicus (Kroyer) and Pseudocalanus sp. ar the two predominant copepods in the Continental Shelf waters immediately south of Long Island, New York. The estimated, in situ, rate of egg production for Centropages typicus ranged from 5 to 230 eggs $female^{-1}\,day^{-1}$ during this study. Variability was partly attributed to seasonal variation in water temperature and partly to variations in the physiological condition of individual females. It could not be shown that the ability to produce eggs varied seasonally due to factors related to food. Egg production by Pseudocalanus sp. is probably from 1 to 10 eggs $female^{-1}\,day^{-1}$. The two reproductive behaviours result in average abundances of adults that are approximately the same, although the peaks are at different times of the year, indicating that Centropages typicus has a higher mortality between the egg and adult stages than Pseudocalanus sp.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 55986, 55987, 56029, 56749

57123 (CONF-7811117—1) **Spatial comparison of methods for assessing water supply and demand.** Shepherd, A.D. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A03/MF A01.

From 33. Association of America Geographers annual meeting of the southeastern division; Athens, GA, USA (19 Nov 1978).

References are often made by planners and policymakers regarding water availability for energy and other purposes. Frequently, however, judgments are biased by an environmental perception of an ubiquitously water-rich eastern United States. The county-level approach presented reduces the areal size of the analysis units to a point where the general assumption of equal availability anywhere within a unit is tenable. This not only produces a more accurate means for determining the regional impacts of projected water-use futures, but also may provide a guide for siting of individual facilities and evaluating alternative siting patterns that would minimize negative water resource impacts.

57124 (PB—289365) **Contemporary and historical trace metal loadings to the sediments of four lakes of the Lake Washington drainage. Completion report.** Spyridakis, D.E.; Barnes, R.S. (Washington Univ., Seattle (USA). Dept. of Civil Engineering). 16 Oct 1978. Contract DI-14-34-0001-6050. 78p. NTIS PC A05/MF A01.

Contemporary and historical loadings of lead, zinc, and copper to the profundal sediments of Lakes Washington, Sammamish, Chester Morse, and Findley were determined using chemical analysis and ^{210}Pb dating of sediment cores. Elemental sedimentation rates, a cross product of the sedimentation rate, and sediment concentration of a given element, were corrected for natural background concentrations and rates, and extrapolated across established sediment accumulating areas to give a conservative estimate of the pollutional trace metal loadings to each lake. The resulting chronological loadings appeared consistent with the known cultural history of the individual watersheds. Substantial alterations in sedimentation rates were noted in all lakes where deforestation, road building, suburbanization or urbanization had occurred in the lake's watershed. The quantities, elemental ratios and pollutional histories of copper, lead and zinc in the lake sediments indicate that aeolian inputs are the dominant source of trace metal pollution to the lake sediments at the present time.

57125 (PB—290383) **Iowa Department of Environmental Quality, 1976-1977. Annual report.** (Iowa Dept. of Environmental Quality, Des Moines (USA)). 1978. 29p. NTIS PC A03/MF A01.

The Iowa Department of Environmental Quality's Annual Report for fiscal year 1976-77 is organized into three major program areas: Air Quality, Land Quality and Water Quality. Activities of each area are reviewed along with goals for the future. The Department's organizational structure and financial summary complete the report.

57126 Carbon dioxide disposal in the ocean. Mustacchi, C. (Analysis and Development of Energy Systems, Rome, Italy); Armenante, P.; Cena, V. pp 283-289 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Basically, CO_2 can be disposed of into the ocean in three alternative ways: by bubbling and dissolution of untreated flue gases; by dissolution of separated CO_2 in the gaseous or liquid phase; and by abatement with sea water of CO_2 in the power plant and return of the solution to the ocean. Each of the methods is considered as to benefits and disadvantages. It is concluded that if and when it is acknowledged that CO_2 cumulation in the troposphere can be dangerous, no major difficulty and only moderate cost will be involved in its removal. The processes to be preferred are those involving a separation of CO_2 by absorption stripping in the plant. By optimizing the process detail, and the additional cost per electric kWh is expected to be not higher than 20%. The equipment is conventional chemical engineering process units, operated in very conservative design conditions. If anything, our estimates are oversafe inasmuch as they are based upon a detailed design for a 1 GW(e) power station. Assuming a one-order-of-magnitude increase in the unit size of power stations, a sizeable economy of scale is in order, and removing the CO_2 to the ocean can entail an increase price per kWh of barely 12 to 15%. Some small verification effort should be devoted to the dissolution aspects where most of the uncertainties lie. Sinking a number of CO_2 bottles at depth 150 to 200 m and monitoring pH at various distances and times is a minor undertaking for oceanographers and should be considered at this time.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 56130

WATER

REFER ALSO TO CITATION(S) 56132, 56133, 56134, 56139, 56140, 56142

THERMAL EFFLUENTS MONITORING AND TRANSPORT

57127 (NUREG/CR—0631) **Quantitative assessment of aquatic impacts of power plants.** McKenzie, D.H.; Arnold, E.M.; Skalski, J.R.; Fickeisen, D.H.; Baker, K.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1979. Contract EY-76-C-06-1830. 115p. (PNL—2891). Dep. NTIS, PC A06/MF A01.

Progress is reported in a continuing study of the design and analysis of aquatic environmental monitoring programs for assessing the impacts of nuclear power plants. Analysis of data from Calvert Cliffs, Pilgrim, and San Onofre nuclear power plants confirmed the generic applicability of the control-treatment pairing design suggested by McKenzie et al. (1977). Substantial progress was made on the simulation model evaluation task. A process notebook was compiled in which each model equation was translated into a standardized notation. Individual model testing and evaluating was started. The Aquatic Generalized Environmental Impact Simulator (AGEIS) was developed and will be tested using data from Lake Keowee, South Carolina. Further work is required to test the various models and perfect AGEIS for impact analyses at actual power plant sites. Efforts on the hydrologic modeling task resulted in a compendium of models commonly applied to nuclear power plants and the application of two well-received hydrodynamic models to data from the Surry Nuclear Power Plant in Virginia. Conclusions from the study of these models indicate that slight inaccuracies of boundary data have little influence on mass conservation and accurate bathymetry data are necessary for conservation of mass through the model calculations. The hydrologic modeling task provides valuable reference information for model users and monitoring program designers.

57128 (PB—289369) **Effects of thermal discharge upon a subarctic stream. Completion report.** Carlson, R.F.; Tilsworth, T.; Hok, C. (Alaska Univ., Fairbanks (USA). Inst. of Water Resources). Jun 1978. 69p. NTIS PC A04/MF A01.

The Fairbanks Municipal Utilities System power plant uses the Chena River, a subarctic stream, as its primary cooling water discharge source. The heated discharge has a number of effects, the most notable of which is the creation of an extensive downstream open water section during the winter when the river is normally ice covered.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 57116

REGULATIONS

REFER ALSO TO CITATION(S) 56750, 56751, 56775, 56776

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 56128, 56789

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 56015, 56739, 56740, 56742, 56743, 56749, 56750, 56751, 56775, 56776, 57106

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 56210, 56749, 56750, 56751, 56775, 56776, 57116

57129 (CONF-781229—1) **Preliminary assessment of the environmental impacts of the Satellite Power System (SPS).** Halverson, S.L.; Rote, D.M.; Rush, C.M.; Davis, K.; White, M.; Cahill, D.F. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 19p. Dep. NTIS, PC A02/MF A01.

From Joint conference on energy and aerospace; London, UK (4 Dec 1978).

The impact of the Satellite Power System (SPS) Microwave Power Transmission System (MPTS) as well as impacts related to other elements of the total SPS on the environment are being determined. The goal of these programs is to advance the state of knowledge by the year 1980 to the point where an assessment can be made of the probability and severity of the impacts of the SPS. Assessments will be made of the effects on the health and safety of the public, and occupationally involved personnel, and the ecology; the upper and lower atmosphere including climatological impacts; and on communications systems including electromagnetic compatibility, the effects of microwave heating of the ionosphere and magnetosphere, and the effects of F-layer depletion by launch vehicle and transport vehicle effluents. If the assessment indicates that the impacts are acceptable or that feasible mitigating strategies can be implemented and if other related assessments (the impact on society and a competitive comparison of the SPS with other energy alternatives) are favorable, a decision may be made to implement the development of the SPS related technologies. This paper identifies postulated effects and summarizes the research efforts to determine whether or not these effects will occur.

BIOMEDICAL SCIENCES, BASIC STUDIES

REFER ALSO TO CITATION(S) 57174

57130 Number of evolutionary trees. Felsenstein, J. (Univ. of Washington, Seattle). *Syst. Zool.;* **27**: No. 1, 27-33(Mar 1978).

A simple method of counting the number of possible evolutionary trees is presented. The trees are assumed to be rooted, with labelled tips but unlabelled root and unlabelled interior nodes. The method allows multifurcations as well as bifurcations. It makes use of a simple recurrence relation for T(n,m), the number of trees with n labelled tips and m unlabelled interior nodes. A table of the total number of trees is presented up to n = 22. There are 282,137,824 different trees having 10 tip species, and over 8.87×10^{23} different trees having 20 tip species. The method is extended to count trees some of whose interior nodes may be labelled. The principal uses of these numbers will be to double-check algorithms and notation systems, and to frighten taxonomists.

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 57168, 57177, 57190, 57192

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 56995, 57169, 57172, 57173, 57180, 57184, 57185, 57186, 57187, 57188, 57192

57131 (LA-UR—79-2424) Detection of early malignant changes in tissue cultured cells using a novel tumorigenicity assay in nude mice. Wells, R.S.; Campbell, E.W.; Holland, L.M.; Schwartzendruber, D.E.; Kraemer, P.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 26p. (CONF-790922—1). Dep. NTIS, PC A03/MF A01.

From Workshop on nude mice; Bozeman, MT, USA (6 Sep 1979).

Cultured cells were tested for tumorigenicity in nude mice using a new test involving implantation of cells grown on small gelatin sponges. The test was applied to mouse, hamster, and human cells, and the results were compared to a conventional tumorigenicity assay (injection of cell suspensions). The sponge assay was at least as sensitive as the conventional assay in all cases tested so far. In several instances the sponge assay could detect events not seen in the standard assay. Use of the sponge assay has led to interesting possibilities for studying in vitro and early in vivo cellular changes that may be associated with the ability to form tumors. In studies with two human squamous cell carcinoma cell lines, the two assays yielded comparable results. Such cell lines might provide a system in which the lack of terminal differentiation within a cell population could be examined as a parameter of neoplastic change.

57132 Reversibility of nucleosome conformation perturbed by urea. Zama, M.; Olins, D.E.; Wilkinson-Singley, E.; Olins, A.L. (Oak Ridge National Lab., TN). *Biochem. Biophys. Res. Commun.;* **85**: No. 4, 1446-1452(29 Dec 1978).

Monomer nucleosomes (ν_1) from chicken erythrocyte nuclei were diluted into 9 M urea plus 0.2 mM EDTA (pH 7.0), and urea was removed by dialysis. The ν_1 thus obtained were fractionated by sucrose gradient ultracentrifugation. Each fraction was examined in 0.2 mM EDTA for reversibility of ν_1 structure perturbed by urea. At least 30% of the initial amount of ν_1 exposed to urea was restored to the original structure, as shown by sedimentation velocity, electron microscopy, circular dichroism, thermal melting and fluorescence of ν_1 labeled with N-(3-pyrene) maleimide on thiol groups of H3 histone.

57133 Defective C-type retrovirus particles secreted by L1210 leukemia cells. Kennel, S.J.; Tsakeres, F.; Kelly, P.A.; Allison, D.P. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Cancer Res.;* **38**: 4574-4579(Dec 1978).

Cultures of 1210 leukemia cells (L1210) have been found to release C-type retrovirus. Since L1210 is used as a common model system in cancer research, the potential influence of these virus particles in the course of tumor cell growth was studied. The virus particle was found to be nononcogenic and noninfectious in standard assays for xenotropic and ecotropic murine retroviruses. The virus, designated as L1210 virus, had a normal complement of viral proteins, except that it has no detectable gp70 (a glycoprotein with a molecular weight of 70,000). Quantitative radioimmunoassay for the major structural protein, p30 (a protein with a molecular weight of 30,000) indicated that the virus is at least 1000-fold more defective than are ecotropic viruses such as AKR and Moloney leukemia virus. L1210 cells grown in vitro released about 20-fold more particle-associated p30 than did in vivo-cultured cells, but cell-associated p30 and gp70 were found at similar levels. Both in vitro- and in vivo-cultured cells displayed gp70 on their surfaces that appeared to be of larger molecular weight than gp70's from most ecotropic viruses. Cells grown in vitro released a high level of non-virion-associated gp70 into the growth medium, but the high concentration of gp70 in the serum of normal DBA/2 mice precluded such measurements on in vivo-cultured cells. These results indicate that L1210 virus does not act as a classical infectious leukemia virus during growth of L1210 cells, but the presence of relatively large amounts of viral antigens in these cells may affect the immune response to them.

57134 Inhibition of DNA replicon initiation by 4-nitroquinoline 1-oxide, Adriamycin, and ethyleneimine. Painter, R.B. (Univ. of California, San Francisco). *Cancer Res.;* **38**: 4445-4449(Dec 1978).

The effects of three widely differing chemical carcinogens, 4-nitroquinoline 1-oxide, Adriamycin, and ethyleneimine, on DNA replication were studied by pulse labeling of DNA with [^{3}H]thymidine and sedimentation analysis with alkaline sucrose gradients. At doses that reduced the rate of DNA synthesis to 30 to 60% of control values, only ethyleneimine produced damage that resulted in lower molecular weights of parental DNA. All three chemicals inhibited replicon initiation, but to differing extents. Inhibition of replicon intitiation was the first clearly identified effect of 4-nitroquinoline 1-oxide and was the main cause of inhibition of DNA synthesis. Ethyleneimine caused severe inhibition of replicon initiation, but blocks to chain elongation also contributed significantly to the inhibition of overall DNA synthesis. Adriamycin affected replicon initiation to a small but significant extent; the primary cause of inhibition of DNA synthesis by this drug was a slowing of the rate of chain elongation. These results indicate that inhibition of replicon initiation is an important mechanism for the action of DNA-damaging agents in mammalian cells and strengthen the concept that control of DNA replication depends on the structural integrity of a chromosomal subunit that consists of several replicons.

57135 Multiple forms of alpha-galactosidase of the mouse and their use as a cell marker in tumorigenesis. Tobler, J.E.; Jacobson, K.B. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Natl. Cancer Inst.;* **61**: No. 5, 1263-1268(Nov 1978).

α-galactosidase was examined as a possible biochemical marker for study of cellular kinetics of tumorigenesis in the mouse [(101 x C3Hf)F_1 x (C57BL/6RL x SEC/RL)F_1]. Enzyme activity was present in all tissues examined and was maintained in high, constant amounts in adult tissues. Multiple forms of α-galactosidase were isolated, one set by preparative gel electrophoresis and another by ion exchange chromatography. The two electrophoretic forms (the faster and the slower) compared with respect to their pH optima, K/sub m/ (Michaelis constant), heat stabilities, and inhibitor sensitivities were found to be indistinguishable by these characteristics. Inasmuch as neuraminidase treatment removed the electrophoretic difference, these two forms probably represented posttranscriptional modifications of the main form of α-galactosidase. DEAE-cellulose (DE-52) chromatography, however, resolved at least two major forms (peak I and peak II) that were independent of the electrophoretic forms. Peak I was unstable to electrophoresis and sensitive to pH changes and heat, had a high K/sub m/ for the artificial substrate 4-methylumbelliferyl-α-D-galactoside, and was different from peak II by these criteria. Gel filtration experiments indicated that peak I could exist as proteins of 29,000 and 52,000 molecular weights, whereas peak II was observed to have a molecular weight of 125,000. Attempts to interconvert the two chromato-

graphic forms failed. Possibly, peaks I and II are unrelated structurally and represcnt two different enzymes.

57136 Amino acid sequence of a progesterone-binding protein. Popp, R.A.; Foresman, K.R.; Wise, L.D.; Daniel, J.C. Jr. (Oak Ridge National Lab., TN). *Proc. Natl. Acad. Sci. U.S.A.;* **75**: No. 11, 5516-5519(Nov 1978).

The amino acid sequence of blastokinin, also called uteroglobin, has been determined by a combined study of both the intact native molecule and the peptide fragments resulting from tryptic and chymotryptic digestions. Sequence analyses performed by automated methods and by sequential digestion with leucine aminopeptidase and carboxypeptidase Y demonstrate that blastokinin is a dimer of identical 69-amino acid subunits held together in parallel orientation by two disulfide bridges at positions 3 and 68. The polypeptide chains are further characterized by the absence of tryptophan residues and by single residues of histidine and tyrosine at positions 8 and 21, respectively. Six of eight amino acids, positions 17 to 24, near the progesterone binding site of blastokinin contain a hydroxyl group. Knowledge of the chemistry of this receptor site should allow better perspectives of the chemistry of molecules in normal tissues that are dependent on progesterone for growth and development, as well as compounds that could act as cancer antagonists for endocrine therapy of hormone-dependent tumors.

57137 Synthesis of peptides of arginine chloromethyl ketone. Selective inactivation of human plasma kallikrein. Kettner, C.; Shaw, E. (Brookhaven National Lab., Upton, NY). *Biochemistry;* **17**: No. 22, 4778-4784(31 Oct 1978).

Synthetic procedures have been developed for the preparation of peptides of arginine chloromethyl ketone and applied in the preparation of affinity labels which correspond to the -Pro-Phe-Arg-C terminus of bradykinin, a physiological cleavage site of kallikrein in kininogen. Two such reagents, Ala-Phe-ArgCH_2Cl and Pro-Phe-ArgCH_2Cl, proved to be highly effective as well as selective affinity labels for human plasma kallikrein. For example, Pro-Phe-ArgCH_2Cl inactivates plasma kallikein 50% in 24 min at a concentration of 2 x 10^{-8} M, while other trypsin-like proteases are less susceptible in inactivation than kallikrein, differing by a factor of 48 for plasmin and factors of 10^2 to 10^5 for factor X/sub a/, thrombin, and urokinase. The affinity of human plasma kallikrein for Ala-Phe-ArgCH_2Cl (K/sub i/ = 0.078 μM) is about 60 times that for Ala-Phe-LysCH_2Cl (K/sub i/ = 4.9 μM), whereas human plasmin exhibits about the same affinity for the former affinity label (K/sub i/ = 1.3 μM) as for the latter (K/sub i/ = 0.83 μM). The rate constants for the irreversible step of the affinity labeling reaction, k_2, are similar for all affinity labels tested with the individual proteases: 0.35 min^{-1} for plasma kallikrein and 0.18 min^{-1} for plasmin.

57138 Experimental evidence for secondary protein-chromophore interactions at the Schiff base linkage in bacteriorhodopsin: molecular mechanism for proton pumping. Lewis, A.; Marcus, M.A.; Ehrenberg, B.; Crespi, H. (Argonne National Lab., IL). *Proc. Natl. Acad. Sci. U.S.A.;* **75**: No. 10, 4642-4646(Oct 1978).

Resonance Raman spectroscopy of the retinylidene chromophore in various isotopically labeled membrane environments together with spectra of isotopically labeled model compounds demonstrates that a secondary protein interaction is present at the protonated Schiff base linkage in bacteriorhodopsin. The data indicate that although the interaction is present in all protonated bacteriorhodopsin species it is absent in unprotonated intermediates. Furthermore, kinetic resonance Raman spectroscopy has been used to monitor the dynamics of Schiff base deprotonation as a function of pH. All results are consistent with lysine as the interacting group. A structure for the interaction is proposed in which the interacting protein group in an unprotonated configuration is complexed through the Schiff base proton to the Schiff base nitrogen. These data suggest a molecular mechanism for proton pumping and ion gate molecular regulation. In this mechanism, light causes electron redistribution in the retinylidene chromophore, which results in the deprotonation of an amino acid side chain with pK > 10.2 +- 0.3 (e.g., arginine). This induces subsequent retinal and protein conformational transitions which eventually lower the pK of the Schiff base complex from > 12 before light absorption to 10.2 +- 0.3 in microseconds after photon absorption. Finally, in this low pK state the complex can reprotonate the proton-deficient high pK group generated by light, and the complex is then reprotonated from the opposite side of the membrane.

57139 Dephosphorylation of histones H1 and H3 during the isolation of metaphase chromosomes. D'Anna, J.A.; Gurley, L.R.; Deaven, L.L. (Univ. of California, Los Alamos, NM). *Nucleic Acids Res.;* **5**: No. 9, 3195-3207(Sep 1978).

Histones have been extracted from isolated metaphase chromosomes prepared by the method of Wray and Stubblefield and by a Nonidet P-40 detergent procedure based on the method of Wigler and Axel. Analysis of the densitometer profiles of long polyacrylamide gels shows that the mitotic phosphorylations of histone H1 (H1/sub M/) and histone H3 are extensively depleted during chromosome isolation. These data indicate that CHO metaphase chromosomes prepared by standard methodologies do not represent in vivo chromosomes with respect to their histone phosphorylations; therefore, current chemical and structural studies of isolated metaphase chromosomes may require further clarification.

57140 Mutagenicity of N-nitrosopiperazine derivatives in Salmonella typhimurium. Rao, T.K.; Young, J.A.; Lijinsky, W.; Epler, J.L. (Oak Ridge National Lab., TN). *Mutat. Res.;* **57**: 127-134(1978).

Mutagenicity of several nitroso derivatives of piperazine was assayed using histidine auxotrophic strains of Salmonella typhimurium. Nitroso derivatives of piperazine required metabolic activation with preference to phenobarbital induced rat-liver microsomal enzymes. We observed a good correlation between a positive effect in the mutation assay and the carcinogenic potency of the compound. Even though our results are not in complete agreement with earlier published work using several microbial mutation assay systems, the differences we observed demonstrate the predictive value of an in vitro activation system using S. typhimurium to detect carinogenic compoumds as mutagems.

57141 Mutagenicity of methylated N-nitrosopiperidines in Saccharomyces cerevisiae. Larimer, F.W.; Ramey, D.W.; Lijinsky, W.; Epler, J.L. (Oak Ridge National Lab., TN). *Mutat. Res.;* **57**: 155-161(1978).

N-nitrosopiperidine (NP) and a number of methylated derivatives were examined for mutagenicity in Saccharomyces cerevisiae. NP, 2-methyl-NP, 3-methyl-NP, 4-methyl-NP and 3,5-dimethyl-NP were mutagens when metabolic activation (rat-liver microsomes) was provided. 2,6-dimethyl-NP was not a mutagen. The NPs giving a positive response stimulated forward mutation to canavanine resistance (CAN1 → can1) and reversion of the his1-7 missense marker. Neither locus revertants nor suppressors of the lys1-1 ochre marker were induced, nor were revertants of the putative frameshift hom3-10.

57142 Unscheduled DNA synthesis in spermatocenic cells of mice treated in vivo with the indirect alkylating agents cyclophosphamide and mitomen. Sotomayor, R.E.; Sega, G.A.; Cumming, R.B. (Oak Ridge National Lab., TN). *Mutat. Res.;* **50**: 229-240(1978).

Cyclophosphamide (CPA) and mitomen (DMO) are chemical mutagens that require metabolic activation to produce their biological effect. We have used an in vivo UDS assay in various meiotic and postmeiotic germ-cell stages of male mice to study DNA repair after treatment with these chemicals. EMS, a compound requiring no metabolic activation, was also used for comparative purposes. CPA and DMO induced UDS in meiotic through early-to-midspermatid stages, but no UDS was detected in late spermatids and mature sperm. While EMS produced a maximum UDS response in the germ cells immediately after treatment, CPA and DMO did not produce a maximum response until ~ 0.5 to 1 h after injection. This delay is attributed to the time requred for CPA and DMO to be enzymatically converted to active alkylating metabolites. Unlike the results found with EMS, mutation frequencies (dominant lethals, translocations, specific-locus mutations) following CPA treatment are not noticeably reduced in germ-cell stages in which UDS occurred. In the case of DMO, mutations are induced only in mature spermatozoa, and these germ-cell stages represent only a fraction of those in which no UDS is detected. The results with CPA and DMO thus still leave unclear the relationship between DNA repair and the differential spermatogenic response of mice to genetic damage.

57143 Effects of anesthetics on divalent cation binding and fluidity of phosphatidylserine vesicles. Puskin, J.S.; Martin, T. (Univ. of Rochester, NY). *Mol. Pharmacol.;* **14**: 454-462(1978).

Divalent cation binding to sonicated phosphatidylserine (PS) as affected by added anesthetics, was examined by electron paramagnetic resonance (EPR) used in conjunction with the paramagnetic Ca^2+ analogue Mn^2+. Long- and short-chain normal alkanols (up through pentadecanol), benzyl alcohol, cholorform, procaine, and tetracaine all inhibited Mn^2+ binding to PS. With increasing chain length, the normal alcohols became more effective in displacing the divalent cation from the vesicles. This appeared to be related to the dependence of alcohol lipid/water partition coefficients on the number of carbons in the methylene chain. Chloroform, on the other hand, although reported to be comparable to hexanol in its partitioning characteristics and anesthetic potency, was a much weaker inhibitor of manganese binding that the latter. The perturbation of PS fluidity by the anesthetics was monitored through EPR spectral observations on a cholestane spin probe.When anesthetic concentrations were adjusted approximately to equalize effects on manganese binding, the lower normal alkanols, benzyl alcohol, and chloroform all fluidized the vesicles substantially, as evidenced by enhanced mobility of the probe. The higher alcohols and the amine anesthetics, in contrast, produced little or no fluidization of the vesicles. The results are discussed in terms of possible molecular explanations for the phenomina and suggested mechanisms for anesthesia.

57144 Effect of calcium on the respiratory responses of corn mitochondria. Day, D.A.; Bertagnolli, B.L.; Hanson, J.B. (Univ. of Illinois, Urbana). *Biochim. Biophys. Acta;* **502**: 289-297(1978).

Tightly coupled respiring corn mitochondria (zea mays L.) respond to calcium addition with a transitory respiratory increase, proton extrusion, and CA^{2+} binding. The extent of response is dependent upon the level of endogenous phosphate, and a large sustained respiratory increase can be obtained with addition of phosphate. However, calcium does not act as a permeant cation in that it will not penetrate with acetate. It appears that the transitory respiratory increase must be linked to the uptake of a calcium phosphate complex, but there is no evidence that transport of the complex serves to produce an electrophoretic calcium uniport. It is believed that calcium phosphate transport in corn is a constitutive property, and not produced by membrane damage.

57145 Efflux and influx of potassium salts elicited by valinomycin in plant mitochondria. Kimpel, J.A.; Hanson, J.B. (Univ. of Illinois, Urbana). *Plant Sci. Lett.;* **11**: 329-335(1978).

The addition of valinomycin to corn mitochondria (Zea mays L., WF9x Mo 17) which have come to steady state osmotic swelling in 5 mM potassium phosphate produces additional energy-linked swelling. If the same experiment is done with 5 mM potassium sulfate, the addition of valinomycin produces energy-linked shrinkage. This shrinkage in sulfate is dependent upon high concentrations of mobilized K^+, and upon an apparent high resistance to sulfate transport. If resistance to phosphate transport is introduced with mersalyl, an energy-linked shrinkage similar to that in sulfate is produced. The data are explained in terms of relative resistance to cation and anion transport.

57146 Cyclic electron transport in isolated intact chloroplasts: further studies with antimycin. Mills, J.D.; Slovacek, R.E.; Hind, G. (Brookhaven National Lab., Upton, NY). *Biochim. Biophys. Acta;* **504**: 298-309(1978).

Antimycin has been used to study the role of cyclic electron transport in isolated intact chloroplasts maintained under aerobic conditions. At all light intensities, antimycin inhibits CO_2 fixation when assay conditions are optimal. When turnover of the Calvin cycle is inhibited, antimycin stimulates bicarbonate-dependent O_2 evolution. Energy-dependent processes such as chlorophyll a and 9-aminoacridine fluorescence quenching, and light-scattering (apparent absorption) changes are inhibited by antimycin. The results suggest that cyclic electron transport contributes to photophosphorylation under aerobic conditions and is obligatory as a source of ATP during the most active periods of CO_2 fixation in vivo. Cyclic electron transport can be stimulated either by inhibiting Photosystem II activity or increasing the turnover of Photosystem I relative to Photosystem II. These effects are interpreted in terms of the need for correct redox poising of carriers in the pathway in order to sustain maximum rates of cyclic electron flow. Binding studies indicate the presence of a high affinity antimycin binding site on chloroplast membranes. The stoichiometry and dissociation constant of the high affinity site are consistent with the idea that antimycin inhibits cyclic electron transport by binding to a b-type cytochrome in the thylakoid membrane.

57147 Electron acceptors associated with P-700 in Triton solubilized Photosystem I particles from spinach chloroplasts. Sauer, K. (Univ. of California, Berkeley); Mathis, P.; Acker, S.; Van Best, J.A. *Biochim. Biophys. Acta;* **503**: 120-134(1978).

Flash-induced absorption changes of Triton-solubilized Photosystem I particles from spinach were studied under reducing and/or illumination conditions that serve to alter the state of bound electron acceptors. By monitoring the decay of P-700 following each of a train of flashes, we found that P-430 or components resembling it can hold 2 equivalents of electrons transferred upon successive illuminations. This requires the presence of a good electron donor, reduced phenazine methosulfate or neutral red, otherwise the back reaction of P-700 with P-430 occurs in about 30 ms. If the two P-430 sites, designated Centers A and B, are first reduced by preilluminating flashes or chemically by dithionite under anaerobic conditions, then subsequent laser flashes generate a 250 μs back reaction of P-700, which we associate with a more primary electron acceptor A_2. In turn, when A_2 is reduced by background (continuous) illumination in presence of neutral red and under strongly reducing conditions, laser flashes then produce a much faster (3 μs) back reaction at wavelengths characteristic of P-700. We associate this with another more primary electron acceptor, A_1, which functions very close to P-700. The organization of these components probably corresponds to the sequence P-700-A_1-A_2-P-430[/sub B/sup A/]. The relation of the optical components to acceptor species detected by EPR, by electron-spin polarization or in terms of peptide components of Photosystem I is discussed. Preliminary experiments with broken chloroplasts suggest that an analogus situation occurs there, as well.

57148 Characterization of two adenosine 3':5'-phosphate-dependent protein kinase species from Chinese hamster ovary cells. Li, A.P.; Hsie, A.W. (Oak Ridge National Lab., TN). *Biochim. Biophys. Acta;* **527**: 403-413(1978).

Chinese hamster ovary cells exhibit several characteristic morphological and physiological responses upon treatment with agents which increase the intracellular level of adenosine 3':5'-phosphate (cyclic AMP). To better understand the mechanism of these cyclic AMP-mediated responses, we separated two cyclic AMP-dependent protein kinases (ATP:protein phosphotransferase, EC 2.7.1.37) (protein kinase I and protein kinase II) from the cytosol of Chinese hamster ovary cells by DEAE-cellulose chromatography and studied their properties. Protein kinase I is eluted at a lower salt concentration than protein kinase II and is stimulable to 10 times its basal catalytic activity, while protein kinase II is stimulable only 2-fold. Both kinases are completely dissociated by cyclic AMP and inhibited by specific cyclic AMP-dependent protein kinase inhibitor. They have similar K/sub m/ values for magnesium (approximately 1 mM), cyclic AMP (approximately 60 mM), and ATP (approximately 0.1 mM), and the dissociation constant (K/sub dis/) for cyclic AMP (approximately 13 nM) is the same for both enzymes. However, they appear to have different substrate preferences and cyclic AMP-binding properties in that cyclic AMP bound to protein kinase II exchanges readily with free cyclic AMP, while that bound to protein kinase I is not exchangeable. The native enzymes have different sedimentation coefficients (6.4 S for protein kinase I and 4.8 S for protein kinase II), whereas those of the activated enzymes are the same (2.9 to 3.0 S). It appears that the two cyclic AMP-dependent protein kinases which differ from each other in their regulatory subunits may play different roles in the mediation of cyclic AMP action in Chinese hamster ovary cells.

57149 Catalyzed cis-trans isomerization of retinals by crude tissue extracts. Sack, R.A. (State Univ. of New York, NY); Seltzer, S. *Vision Res.;* **18**: 423-426(1978).

Tissue extracts in a neutral anaerobic environment have previously been shown to catalyze 11-cis-retinal → all-trans + 13-cis-retinal trans-retinal to the 9-cis isomer. The latter reaction results in the formation of artifactual isohodopsin. The authors find that in an aerobic, mildly alkaline environment, however, a reaction of contrasting specificity is observed. While 11-cis-retinal → all-trans + 13-cis-retinal, 9-cis is found to equilibrate with 9,13-dicis-retinal. No 9-cis is formed from trans or 13-cis-retinals. A rationale is given for the predominant reactivity about the C-13 double bond of retinals in the presence of this apparent high molecular weight protein(s) catalyst.

CYTOLOGY

REFER ALSO TO CITATION(S) 57139, 57142, 57145, 57165, 57167, 57169, 57178, 57179, 57180, 57188

57150 Chromosomal DNA replication in higher plants. Van't Hof, J.; Bjerknes, C.A. (Brookhaven National Lab., Upton, NY). *Bioscience;* **29**: No. 1, 18-22(Jan 1979).

The object of this paper is to acquaint readers with chromosomal DNA fiber autoradiography that uses light microscopy. Higher plant chromosomes are emphasized because the techniques were recently applied with success to plant DNA. The technique and analytical rationale were described in detail. An analysis of autoradiograms, rate of fork movement and replicon size are discussed.

57151 Repopulation of denuded tracheal grafts wth normal, preneoplastic, and neoplastic epithelial cell populations. Terzaghi, M.; Nettesheim, P.; Williams, M.L. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Cancer Res.;* **38**: 4546-4553(Dec 1978).

The purpose of these experiments was to study the in vivo growth characteristics of nonmalignant and malignant epithelial cell cultures maintained in vitro for various lengths of time. Cell cultures tested originated from normal or carcinogen-exposed tracheal epithelium of Fischer 344 rats. The cultures were inoculated into isolated tracheas, which were then grafted to isogenic recipients. Inoculation of denuded tracheas with 1-week-old primary cultures of normal tracheal epithelium resulted in the reestablishment of a nearly normal mucociliary tracheal lining within 1 to 2 weeks. Injection of primary epithelial cultures older than 1 week failed to reestablich an epithelial lining. Inoculation with preneoplastic epithelial cell lines resulted in the establishment of a well-organized, keratinizing squamous epithelium, which remained stable for at least 6 weeks if the recipient was immunosuppressed, but which was rejected at 4 weeks in immunocompetent hosts. Inoculation with a neoplastic cell line resulted in the establishment of a well-organized squamous epithelium for 3 to 4 weeks and the development of disorganization, exophytic growth, and invasion at 4 to 6 weeks in immunosuppressed recipients. In immunocompetent hosts the epithelial lining was completely rejected within 2 weeks. When cells from a highly malignant squamous cell carcinoma line were inoculated into tracheas with an intact epithelial lining, only a few isolated nests of malignant cells were observed at 6 weeks. Repopulation of denuded

tracheas with cells from the same tumor line resulted in the establishment of an atypical squamous lining at 1 week. At 2 weeks invasion was widespread, resulting in destruction of the tracheal grafts. This in vivo culture system is well suited to the study of growth and differentiation characteristics of carcinogen-altered or preneoplastic epithelial cell populations.

57152 Morphological and quantitative analysis of spermatogonia in mouse testes using whole mounted seminiferous tubules. I. The normal testes. Huckins, C.; Oakberg, E.F. (Oak Ridge National Lab., TN). *Anat. Rec.;* **192**: No. 4, 519-527(Dec 1978).

The spermatogonial populations in ten normal adult mice were analyzed using whole mounted seminiferous tubules. The undifferentiated A spermatogonia as well as the six generations of differentiating spermatogonia were clearly identifiable on whole mounts. Description plus quantitation of these cell types revealed that they behaved in essentially the same manner as their counterparts in the rat. Single undifferentiated A cells were classified as type A/sub s/ stem cell spermatogonia. They were distributed throughout the seminiferous epithelium, and by periodic mitoses, maintained their stock and furnished cells which would eventually differentiate. Although initially resembling the A/sub s/ spermatogonia, the progeny which were destined to differentiate were classified as type A/sub al/ spermatogonia because they were linked by cytoplasmic bridges, and because they usually underwent one or more synchronous mitotic divisions to form short chains of aligned cells. Ultimately, division of A/sub al/ cells were no longer seen, and the cells appeared to gradually acquie the typical morphological characteristics of A_1 spermatogonia; these continued to differentiate according to the well-established pattern. It was concluded that the cyclic production of cohorts of A_1 cells in this manner would ensure a continual supply of spermatogonia for differentiation.

57153 Long-term growth and differentiation of Xenopus oocytes in a defined medium. Wallace, R.A.; Misulovin, Z. (Oak Ridge National Lab., TN). *Proc. Natl. Acad. Sci. U.S.A.;* **75**: No. 11, 5534-5538(Nov 1978).

Xenopus laevis oocytes over a size range of 0.15 to 0.78 mm^3 were dissected from their follicles and cultured in a defined medium for up to 28 days. Oocytes grew at average rates of 0.021 $mm^3.day^{-1}$ in the absence of insulin and 0.030 $mm^3.day^{-1}$ in the presence of insulin. The latter average growth rate corresponds to the fastest growth rate reported to date for oocytes in vivo. Oocytes grown in vitro can reach a size of at least 1.43 mm^3, which is larger than the maximum size generally found in vivo. During growth in vitro; oocytes also acquire both a normal pigment pattern and, once they reach about 0.7 mm^3, the ability to undergo complete maturation as a response to externally applied progesterone. These results show that Xenopus oocytes freed of their follicular investments are able to grow and differentiate in vitro.

57154 Comment on the loss of immunogenicity of tumor cells caused by freezing. Leibo, S.P. (Oak Ridge National Lab., TN). *Cancer Immunol. Immunother.;* **3**: 211-213(1978).

In this letter, the author reviews the work done by Bartlett, et al. on the storage of human tumor tissue and its later use as an autologous vaccine in the immunotherapy of cancer. Bartlett, et al. concluded that tumor cells which were viable after storage in liquid nitrogen were significantly less immunogenic than cells used without prior freezing. The author gives reasons for suggesting that the conclusion of Bartlett, et al., and its corollary (that frozen-thawed cells are not suited for immunotherapy) may be unduly pessimistic. He suggests the following sources for the loss of immunogenicity, the nature and concentration of the suspending medium, seeding of the samples with ice crystals, cooling rate, warming rate, and the dilution of the suspending medium.

57155 Mutagenic and chromosome-breaking effects of azide in barley and human leukocytes. Sander, C.; Nilan, R.A.; Kleinhofs, A.; Vig, B.K. (Washington State Univ., Pullman). Contract E-45-1-2221. *Mutat. Res.;* **50**: 67-75(1978).

Azide (10^{-3} M, solution buffered at pH 3) is more effective in inducing mutations in embryonic shoots of seeds germinated between 8 and 16 h than in non-germinated seeds and in seeds germinated between 1 and 8 h and 16 to 28 h. This peak of chlorophyll-deficient seedling mutation frequency coincides with maximum frequencies of seedling lethals and DNA replication in the cells of the embryonic shoot. The mutation data suggest azide may only act on replicating DNA. Azide induced no chromosome-aberration frequencies significantly above controls in (1) embryonic shoots of barley seeds germinated for 8 to 12 h, (2) microspores of barley and (3) human leukocytes. It appears to be a point-mutation mutagen.

57156 Comparative mutagenesis of plant flavonoids in microbial systems. Hardigree, A.A.; Epler, J.L. (Oak Ridge National Lab., TN). *Mutat. Res.;* **58**: 231-239(1978).

The plant flavonoids quercetin (3,5,7,3',4'-pentahydroxyflavone), morin (3,5,7,2'4'-pentahydroxyflavone), kaempferol (3,5,7,4'tetrahydroxyflavone), chrysin (5,7-dihydroxyflavone), fisetin (3,7,3',4'-tetrahydroxyflavone), myricetin (3,5,7,3',4',5'-hexahydroxyflavone), myricitrin (myricetin-3-rhamnoside), hesperetin (3',5,7-trihydroxy-4'-methoxyflavanone), quercitrin (quercetin-3-L-rhamnoside), rutin (quercetin-3-rhamnosylglucoside or quercetin-3-rutinoside), and hesperidin (hesperetin-7-rutinoside) have been assayed for mutagenicity in the Salmonella/microsomal activation system. Quercetin, morin, kaempferol, fisetin, myricetin, quercitrin and rutin were mutagenic in the histidine reversion system with the frameshift strain TA98. The flavonols quercetin and myricetin are mutagenic without metabolic activation, although more effective when a rat liver microsomal preparation (S-9) is included; all others require metabolic activation. Flavonoids are common constituents of higher plants, with extensive medical uses. In addition to pure compounds, we have examined crude extracts of tobacco (snuff) and extracts from commonly available nutritional supplements containing rutin. Mutagenic activity can be detected and is correlated with the flavonoid content.

57157 Chromosomal isolabelling caused by three rounds of synthesis in late replicating regions. Wolff, S.; Bodycote, J.; Rodin, B. (Univ. of California, San Francisco). *Chromosoma;* **69**: 179-183(1978).

Isolabelling only occurs in CHO cells that have been allowed to replicate for more than 2 but less than 3 cell divisions in the presence of BrdU. The isolabelling is confined to late replicating regions of the chromosomes. The staining patterns obtained indicate that BrdU was incorporated three times in these regions and that the isolabelling did not come from the segregation of label in polynemic chromosomes.

57158 Synchronization of Drosophila cells in culture. Rizzino, A.; Blumenthal, A.B. (Univ. of California, San Francisco). *In Vitro;* **14**: No. 5, 437-442(1978).

Drosophila cell lines (Schneider's line 2 and K/sub c/) were synchronized by allowing the cells to enter the stationary phase of growth and then diluting them into fresh culture medium. The cells of both cell lines entered S phase, after an 8- to 14-h delay, in a state of partial synchrony; 60 to 80% of the cell population accumulated in S Phase. Measurements of the cell cycle phases of Schneider's line 2 cells (S = 14 to 16 h; G_2 = 6 to 8 h; M = 0.4 h) were similar to those of K/sub c/ cells.

57159 Hemopoietic effects in mice of a transplanted, granulocytosis-inducing tumor. Reincke, U.; Burlington, H.; Carsten, A.L.; Cronkite, E.P.; Laissue, J.A. (Brookhaven National Lab., Upton, NY). *Exp. Hematol.;* **6**: 421-430(1978).

A transplanted tumor that induces granulocytosis and produces colony stimulating factor (CSF) was studied in mice during several passages. The sequence of events leading to granulocytosis was characterized. Band granulocytes were increased 3 days after tumor inoculation, while simultaneously CFU-s and CFU-c in bone marrow and spleen were transitorily low. This was followed by rapid accumulation of CFU-c and CFU-s in spleen, and by successive waves of increased mitotable and non-mitotable granulocytes in spleen and marrow. In contrast, marrow CFU-c and CFU-s remained normal or slightly decreased.

57160 Preliminary studies of coated complementary freeze-fractured yeast membranes viewed directly in the SEM. Pawley, J.; Hayes, T.L.; Hook, G. (Univ. of California, Berkeley). pp 683-690 of Scanning Electron Microscopy/1978. Vol. II. Hoffman Estates, IL; Scanning Electron Microscopy, Inc. (1978).

Normal or complementary fracture surfaces of frozen biological material, which are usually studied only by replica techniques, may now be observed directly in the SEM using available equipment such as the AMR Bio-Chamber. This paper describes preliminary application of this instrumentation to the study of the yeast Saccharomyces cerevisiae. The yeast was prepared in 20% glycerol as though for normal freeze-fracture and then either frozen onto cardboard disks for fracture using the cold knife in the Bio-Chamber or placed in special holders for one of two type of complementary fracture devices. In the first device, the sample suspension was introduced into two hollow rivets held end-to-end. After freezing and introduction into the chamber the rivets were pulled apart and held with their fracture surfaces up. After coating with Au or Pt-C they were viewed on a cold stage. More success was obtained with a second type of complementary fracture device in the form of a small copper hinge. The sample is introduced between the sides of the hinge when it is closed and fracture takes place when it is opened 180^0 after freezing. Results show that large areas of complementary fracture surfaces can be produced and viewed. Modifications to the SEM scan circuits permit images of both sides of the fracture to have the same handedness. At present the spatial resolution of the technique is about 15 to 20 nm and intra-membrane particles (8 to 12 nm) have not been seen on cold samples. Nor were they seen on lightly Au coated Pt-C replicas prepared in a Balzer's device and viewed on the normal stage. The reason for this failure is not yet clear but may involve: (1) degradation of electron optical performance; (2) coating; (3) contamination; (4) vibration; or (5) insufficient contrast-forming ability of the particles.

57161 Heavy ion microscopy of hydrated cells with SEM imaging of the contact radiograph. Hayes, T.L.; Tobias, C.A.; Yang, T.C. (Univ. of California, Berkeley). pp 233-238 of Scanning Electron Microscopy/1978. Vol. I. Hoffman Estates, IL; Scanning Electron Microscopy, Inc. (1978).

The great penetration and unique modes of interaction of accelerated particle radiation have been utilized for the examination of biological tissue through the use of the heavy ion particle accelerator (Bevlac) combined with the scanning electron microscope examination of the appropriate plastic track detector. As a biological specimen is exposed to a monoenergetic parallel beam of heavy ions (krypton, 8.5 MeV/nucleon), particles that pass through the object will come to rest in a plastic nuclear track detector mounted immediately behind the specimen. The contour envelope of all stopping points mirrors the stopping properties of the specimen. Where the specimen thickness (as measured by electron density) is great, the stopping points are near the surface and where the specimen thickness is small the residual range of particles is greater. An image of electron density distribution, therefore, can be obtained by mapping the depth at which the micro-lesions in the plastic come to an end. For a given particle range, the heavier particle has a much smaller range straggling than a lighter one and there is a much smaller spread in the lateral position of the stopping points for heavier particles. Range straggling, initial beam energy spread and multiple scattering are the important factors in determining minimum detectable difference in electron density within the specimen. The measurement of electron density as a function of track length in such microradiography can theoretically reach a few hundred angstroms for a heavy ion beam with a range of 10 micrometers (sensitivity of a few parts per thousand). In preliminary evaluations, spatial localization (track diameter) down to 800 Å has been demonstrated for specimens of hydrated, unfixed biological material.

57162 Chromosomal aneuploidy in a patient with hypereosinophilic syndrome. Bitran, J.D.; Rowley, J.D.; Plapp, F.; Golomb, H.M.; Ultmann, J.E. (Franklin McLean Memorial Research Inst., Chicago, IL). *Am. J. Med.;* **63**: 1010-1014(Dec 1977).

A patient with a rapidly fatal hypereosinophilic syndrome and a bone marrow chromosomal abnormality, 49,XYY,t(3:5), + 8, + mar, is described. Scanning and transmission electron microscopy of eosinophils failed to reveal any significant abnormalities. Previous cytogentic data on patients with hypereosinophilic syndrome have been deficient in that few studies have been performed with banding technics. These technics may help in the classification of hypereosinophilic syndrome and predict which patients will have a rapidly fatal course.

TRACER TECHNIQUES

57163 Human alpha-fetoprotein in the epidermal cells of Bowen's disease. Soltani, K.; Yachnin, S.; Brickman, F. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *J. Invest. Dermatol.;* **70**: No. 4, 204-206(1978).

Human alpha-fetoprotein (HAFP) was demonstrated in clusters of atypical cells of an extensive Bowen's disease involving the pubic area. Frozen sections were studied by indirect immunofluorescence using monospecific rabbit anti-HAFP antiserum or purified rabbit anti-HAFP antibody followed by staining with fluorescein isothiocyanate (FITC)-labeled goat anti-rabbit γ-globulin and by a direct technique using FITC-labeled rabbit anti-HAFP Fab2 fragments. Sections of fetal liver served as positive controls and sections of adult human skin and liver were used as negative controls. Preabsorption of the anti-HAFP antibodies with purified HAFP blocked the fluorescence. This finding adds Bowen's disease to the list of premalignant disorders which possess HAFP as an oncofetal marker of their malignant potential. HAFP might possibly enhance malignant behavior through interference with cellular immunosurveillance mechanisms.

57164 Increased granulocytic, erythrocytic, and megakaryocytic progenitors in myelofibrosis with myeloid metaplasia. Chikkappa, G.; Carsten, A.L.; Chanana, A.D.; Chandra, P.; Cronkite, E.P. (Brookhaven National Lab., Upton, NY). *Am. J. Hematol.;* **4**: 121-131(1978).

Nucleated cells obtained from blood and/or bone marrow of patients with myelofibrosis with myeloid metaplasia (MMM) were cultured in diffusion chambers (DC) implanted into the peritoneal cavities of irradiated mice. A total of five blood studies and two bone marrow studies were performed using cells obtained from five patients. The DC were harvested at intervals from the host mice and the total and differential cellularity of DC contents were evaluated. The results obtained from MMM cultures were compared with those from similar cultures of blood cells and marrow cells of four and six normal individuals respectively. The proliferation and maturation of the granulocytic, erythrocytic, and megakaryocytic lines in MMM cultures occurred in an orderly fashion as they occur in vivo. The patterns of proliferation and maturation of the three cell lines in cultures after day 7 suggest that they primarily originate from progenitor cells. The numbers of granulocytes in the multiplicative pool, recognizable red cell precursors, and megakaryocytes recovered were significantly greater from the MMM cultures than those from the normal blood or marrow cultures. These results suggest that the blood and marrow cells of MMM patients have increased numbers of progenitors for granulocytes, erythrocytes and megakaryocytes.

GENETICS

REFER ALSO TO CITATION(S) 57155, 57156

57165 Phenotypic expression time of mutagen-induced 6-thioguanine resistance in Chinese hamster ovary cells (CHO/HGPRT system). O'Neill, J.P.; Hsie, A.W. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Mutat. Res.;* **59**: 109-118(1979).

Mutation induction at the hypoxanthine-guanine phosphoribosyl transferase (HGPRT) locus in Chinese hamster ovary (CHO) cells (referred to as the CHO/HGPRT system) can be quantitated by selection for the phenotype of resistance to 6-thioguanine (TG) under stringently defined conditions. The phenotypic expression time, that is, the time interval after mutagen treatment which is necessary before all mutant cells are able to express the TG-resistant phenotype, has been found to be 7 to 9 days in this CHO/HGPRT system when the cells are subcultured every 48 h. Subculture in medium with or without hypoxanthine (HX) utilizing trypsin, ethylenediaminetetraacetic acid (EDTA), or ethylene glycol bis (β-aminoethyl ether)-N,N,N',N'-tetraacetic acid (EGTA) for cell removal yields identical results. When subculture at intervals greater than 48 h is employed, a slight lengthening of the expression time is observed. An alternative method to regular subculture has also been achieved by maintaining the cells in a viable, non-dividing state in serum-free medium. This procedure yields a similar time course of phenotypic expression and thus shows that continued cell division is not essential to this expression process. In addition, this observation offers methodology which can significantly reduce the investment of time and money for mutation induction determinations in this mammalian cell gene mutation assay.

57166 Induction of 6-thioguanine- and ouabain-resistant mutations in synchronized Syrian hamster cell cultures during different periods of the S phase. Tsutsui, T.; Barrett, J.C.; Ts'o, P.O.P. (Johns Hopkins Univ., Baltimore, MD). Contract EY(11-1)3280. *Mutat. Res.;* vp(1978).

Cells of a transformed Syrian hamster line, BP6T, were synchronized by a period of growth in low serum with a subsequent blockade of the cells at the G_1/S boundary by hydroxyurea. This method provided cells with nearly 100% synchrony, although approximately 20% of the cells were non-cycling. The cells were then treated with 10^{-5} M 5-bromodeoxyuridine for 1 of 5 1-h periods during the S phase and subsequently irradiated with near-ultraviolet light for 5 min. The BrdU plus irradiation treatment induced 6-thioguanine- and ouabain-resistant mutants while BrdU alone or irradiation alone was not mutagenic. 6-Thioguanine-resistant mutants were induced only during early S phase by BrdU plus irradiation treatment. Ouabain-resistant mutants, however, were induced in a biphasic pattern during early S phase and also during late S phase. The induction of ouabain-resistant mutants at two distinct periods of S phase suggests the presence of two loci for the gene(s) of Na^+/K^+ ATPase.

57167 XXY genotype in Chinese hamster, C. griseus. Ivett, J.L.; Tice, R.R.; Bender, M.A. (Brookhaven National Lab., Upton, NY). *J. Hered.;* **69**: 128-129(1978).

A case of XXY genotype in the Chinese hamster is reported. This condition was observed during routine chromosome analysis of lymphocytes. Two hundred metaphase cells were examined for chomosomal aberrations and aneuploidy. Among these 177 were scored as having 23 chromosomes (2n for C. griseus = 22). Karyotype analysis of 50 cells revealed that the additional chromosome in each of these cells was an extra x chromosome. No evidence existed to suggest possible mosaicism in blood lymphocytes since the metaphase cells with less than 23 chromosomes appear to have undergone chromosome loss from the XXY genotype rather than presenting a stable karyotype. The animal appeared to be a phenotypically normal male within the same weight and age as the other animals. No other tissues were examined.

METABOLISM

REFER ALSO TO CITATION(S) 57142, 57146, 57147, 57186

57168 (CONF-790762—1) **Circadian manifestations of barbiturate habituation, addiction and withdrawal in the rat.** Ehret, C.F.; Peraino, C.; Meinert, J.C.; Groh, K.R. (Argonne National Lab., IL

(USA)). 1979. Contract W-31-109-ENG-38. 31p. Dep. NTIS, PC A03/MF A01.

From 14. international conference for the Society of Chronobiology; Hanover, F.R. Germany (8 Jul 1979).

The present study uses circadian rhythm observations on rats to include diverse habituation and drug ingestion (phenobarbital) circumstances, including a comparison of the effect of pre-entrainment cycles of programmed feeding and illumination and subsequent conditions of exposure of duration sufficient to permit a steady-state in the appearance of circadian patterns derived from core-temperature telemetry and from automated food-consumption measurements. Finally, measurements were permitted to continue long enough after the drug was withdrawn from the diet to allow characterization of an abstinence syndrome, indicative of addiction.

57169 Mutagenic in vivo metabolite of sodium azide. Owais, W.M.; Zarowitz, M.A.; Gunovich, R.A.; Hodgdon, A.L.; Kleinhofs, A.; Nilan, R.A. (Washington State Univ., Pullman). *Mutat. Res.;* **53**: 355-358(1978).

Experimental evidence is presented for the presence of a mutagenic metabolite formed in vivo in barley embryos exposed to sodium azide. The mutagenic substance found in extracts after removal of free azide by acidification was partially purified by liquid column chromatography and eluted. The fractions were collected and tested for mutagenicity with strain TA 1530. The mutagenic substance eluted as a single nearly [illegible]rical peak in fractions 37 through 49. Preliminary experime[illegible] indicate that the metabolite is quite stable to acid and heat and is insoluble in a number of organic solvents. Data reported here indicate that a mutagenic metabolite was formed. The nature of this metabolite is not yet known. The failure of sodium azide to react with DNA in vitro to produce mutagenic lesions as well as single strand breaks in calf-thymus DNA supports the possibility of in vivo activation of azide.

MEDICINE

57170 Conjecture on the role of dry charges in radiosensitization. Bakale, G.; Gregg, E.C. (Case Western Reserve Univ., Cleveland, OH). *Br. J. Cancer;* **37**: 24-28(1978).

A model of cellular radiation damage that involves dry electrons and holes is proposed and the implications of this model to hypoxic radiosensitization are discussed. The transport and reaction properties of dry charges in the structured water surrounding polar biomolecules are considered and a solvation time of 600 picoseconds in this medium is derived. Pre-solvation charge migration, attachment and recombination and the relevance of these processes to sensitization are discussed. DNA damage by physico-chemical interactions with dry holes is proposed and is shown to be modified by oxygen and other electron affinic sensitizers.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 56995

57171 (LBL—8627) **Tomographic visualization of breast calcifications by ultrasound scattering.** Perez-Mendez, V.; Ortendahl, D.; Sommer, G.; Baker, J.; Wiedenbeck, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Yale Univ., New Haven, CT (USA). Dept. of Radiology; California Univ., San Francisco (USA). Dept. of Radiology). Jan 1979. Contract W-7405-ENG-48. 13p. (CONF-790148—2). Dep. NTIS, PC A02/MF A01.

From IEEE workshop on physics and engineering in computerized tomography; Newport Beach, CA, USA (17 Jan 1979).

Various types of malignant and benign breast tumors are associated with clusters of calcifications with grain sizes 0.1 to 1 mm spread out over volumes of a few cm^3. These clusters have shapes ranging from spherical to elongated chains. A series of phantoms was made and the ultrasound scattering pattern from calcium carbonate grains embedded in a gelatin mixture was measured with 2.25 and 5 MHz transducers. A single send transducer with a few receive transducers placed at angles of 120^0 to 160^0 relative to the forward direction was used. Tomographic images of these distributions were obtained by a combination of transit time recording and positioning of the transducer array. Measurements have been done on grain sizes as small as 0.2 mm and show a clean signal above tissue scattering background.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 57140, 57141, 57156, 57172, 57178, 57179, 57180

57172 Fluorescent probe studies of normal, persistently infected, Rous sarcoma virus-transformed, and trypsinized rat cells. Burleson, G.R.; Kulpa, C.F.; Edwards, H.E.; Thomas, J.K. (Univ. of Notre Dame, IN). *Exp. Cell Res.;* **116**: 291-300(1978).

The fluorescent probes pyrene, pyrene butyric acid and N-phenyl 1-naphthylamine were used to study membranes of normal cells, RSV-transformed cells, cells treated with a proteolytic enzyme, and cells persistently infected with lymphocytic choriomeningitis virus. The lifetimes of excited pyrene and pyrene butyric acid showed only minor changes when these probes were in normal, transformed, trypsinized or persistently infected cells. However, pyrene, but not pyrene butyric acid, lifetimes are shorter in cell membranes than in homogeneous solvents. The quenching of excited pyrene in cells by quencher molecules was slower than corresponding reactions in homogeneous solutions indicating that the probe was screened from the quenchers by the membrane. However, quenching reactions with the pyrene butyric acid probe were similar in cells and homogeneous solvents. This indicates that pyrene and pyrene butyric acid reside in different lipid regions of the membrane. Transformed and trypsinized cells showed increased membrane fluidity compared to normal and persistently infected cells. Membrane fluidity was determined from the excimer/monomer fluorescence ratios of pyrene, and by the polarization of N-phenyl 1-naphthylamine fluorescence. Several techniques distinguished between normal and transformed or trypsinized cells; however, the only parameter unique to viral transformation was a blue shift of the fluorescence maxima of N-phenly 1-naphthylamine. This shift reflected a less polar environment for N-phenyl 1-naphthylamine in virus-transformed cells.

57173 Host-pathogen interactions in plants. Plants, when exposed to oligosaccharides of fungal origin, defend themselves by accumulating antibiotics. Albersheim, P.; Valent, B.S. (Univ. of Colorado, Boulder). *J. Cell Biol.;* **78**: 627-643(1978).

The ability to synthesize phytoalexins is a mechanism by which plants are able to stop the growth of microorganisms which have not become pathogenic on the phytoalexin-producing plant. Although not sufficient for its complete resistence to pathogens, an ability to synthesize phytoalexins is likely to be one essential criterion for a plant to be resistant to pathogens. Plants recognize the presence of many nonpathogenic fungi by recognizing a structural component of the mycelial walls of the fungi. Other microorganisms do not have structural glucans in their walls. There is, likely, some other components of bacteria, for instance, which act as elicitors in plants since it is known that they do elicit phytoalexin production in plants. The authors are attempting to identify a bacterial elicitor. It is known that the soybean pathogen Phytophthora magasperma is an oligosaccharide composed only of glucose. This is of general biological interest since it shows that oligosaccharides can act as regulatory molecules.

MORPHOLOGY

REFER ALSO TO CITATION(S) 57152

PATHOLOGY

REFER ALSO TO CITATION(S) 57151, 57159, 57162

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 57163

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 57137, 57142, 57143, 57145, 57152, 57192

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 56250

BIOMEDICAL SCIENCES, APPLIED STUDIES

57174 (UR—3490-1650) **Brief description of research papers accepted for publication during 1978. Annual report.** (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 24 May 1979. Contract EY-76-C-02-3490. 109p. Dep. NTIS, PC A06/MF A01.

Abstracts (172) of basic and applied research of papers accepted for publication are presented. An author index is included. (PCS)

VACCINE PREPARATION AND OTHER APPLICATIONS

REFER ALSO TO CITATION(S) 57154, 57176

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 57177

57175 (DOE/EV—0045) **Study of anticipated impact on DOE programs from proposed reductions to the external occupational radiation exposure limit.** (Department of Energy, Washington, DC (USA). Div. of Operational and Environmental Safety). 1978. 28p. Dep. NTIS, PC A03/MF A01.

Many years of radiation exposure experience in all phases of nuclear energy applications were surveyed to evaluate the impact of reducing the present DOE limit of 5 rem/yr. Conclusions drawn are: (1) Reduction of the occupational exposure limit would result in significant increase in total accumulated exposure to the current radiation worker population and could require an increase in the work force with attending personnel and administrative problems. (2) Important programs/facilities would have to be abandoned. (3) Some engineering technology is not sufficiently developed to design or operate at the 0.5 rem/yr limit. (4) Exposure reduction to 2.5 rem/yr would significantly increase costs and would result in a small increase in total exposure to the work force. (5) Significant initial capital cost plus increased annual costs would result. (6) The major emphasis in controlling occupational exposure should be on continued work toward further reduction of total man-rem. This should involve continued development of ALAP programs along with improvements in dose measurement and recording methods, more sophisticated exposure records, and containment, handling and remote maintenance techniques. (7) Radiation protection practices at DOE facilities have maintained exposures of the bulk of the nuclear work force substantially below current limits for many years. (8) The current standards of 5 rem/yr is used only as a limit. For example, 97% of the employees receive less than 0.5 rem/yr.

DISINFESTATION

57176 **Decontamination of animal feeds by irradiation.** Vienna; International Atomic Energy Agency (1979). 162p. (STI/PUB—508; CONF-7710213—). UNIPUB, 345 Park Ave. S, New York, NY.

From Advisory group meeting on radiation treatment of animals feed; Sofia, Bulgaria (17 Oct 1977).

Thirteen papers are presented on national status of the technology utilization in Japan, Hungary, and Israel. Nutritional aspects and specific applications are considered. (PCS)

NUCLIDE KINETICS AND TOXICOLOGY

MAN

57177 (NUREG/CR—0635) **Excess cancer incidence in Mesa County, Colorado. Final report.** Cunningham, M.C.; Ferguson, S.W.; Foreman, T. (Colorado Dept. of Health, Denver (USA). Disease Control and Epidemiology Div.). Jul 1979. 99p. NTIS.

The initial phase of this investigation has determined that there is a twofold excess of leukemia incidence for all ages in Mesa County, Colorado, for the period 1970 to 1976. The greatest excess was observed among residents over 65 years of age who developed leukemia 2-1/2 times the expected rate. No excess incidence of lung cancer has been identified. The second phase of the investigation has been case-control study of all adult leukemia deaths since 1960. No significant differences were found beween cases and controls with respect to: years of residence in Mesa Couty, general health status prior to diagnosis, and radiation exposure from tailings buildings. Only two cases and two controls had ever lived in houses with elevated gamma radiation from uranium mill tailings used in construction. Only one case and one control has a cumulative and average annual exposure significantly higher than the other subjects. Leukemia cases had higher socioeconomic levels and more positive family histories of leukemia than controls. No association between tailings structures and leukemia excess was observed.

MICROORGANISMS

REFER ALSO TO CITATION(S) 57120

PLANTS

REFER ALSO TO CITATION(S) 57120

INVERTEBRATES

REFER ALSO TO CITATION(S) 57120

VERTEBRATES

REFER ALSO TO CITATION(S) 57120

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 57174

MICROORGANISMS

REFER ALSO TO CITATION(S) 57127, 57140, 57141

57178 **Mutagenicity of aliphatic nitrosamines in Salmonella typhimurium.** Rao, T.K.; Young, J.A.; Lijinsky, W.; Epler, J.L. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Mutat. Res.;* **66**: 1-7(1979).

Twenty-five aliphatic nitrosamines were examined in the Ames assay for bacterial mutagens, using rat liver S-9 for activation. Of them, 8 carcinogens were mutagenic and 5 non-carcinogens were not mutagenic. However, 2 compounds not carcinogenic in rats were mutagenic and 9 carcinogens were not mutagenic, including 6 that are liver carcinogens in rats.

57179 **Cytotoxicity of synthetic fuel products on Tetrahymena pyriformis. II. Shale oil retort water.** Schultz, T.W. (Univ. of Tennessee); Dumont, J.N.; Kyte, L.M. *J. Protozool.;* **25**: No. 4, 502-509(1978).

Shale oil retort water is obtained by centrifuging the oil/water emulsion produced by oil shale retorting. The ciliate Tetrahymena pyriformis was exposed to retort water; 2,1, and 0.5% initially increased motility; longer exposures decreased motility. Three, 4, and 5% all decreased motility. Cell lysis was directly related to concentration; after 24 h, population densities were 0, 10, and 25% of controls for 2, 1, and 0.5% retort water, respectively. Oxygen consumption paralleled the motility pattern: at lower concentrations it increased initially but decreased with extended exposures while at higher concentrations it decreased rapidly. The most striking cytologic alteration of cells exposed to the toxicant occurred in the membranes; alterations of mucocysts and glycogen content were also observed, but mitochondrial changes were not. Population growth was affected at much lower concentrations than the other test indices. The growth of test populations reached a plateau at values inversely related to concentration: concentrations $< 0.4\%$ had no effect on growth rate.

57180 **Differential sensitivity of DNA replication and repair in permeable Escherichia coli exposed to various monofunctional methylating or ethylating agents.** Hellermann, G.R. (Univ. of Tennessee, Knoxville); Billen, D. *Chem.-Biol. Interact.;* **23**: 305-314(1978).

Escherichia coli cells made permeable to deoxynucleoside triphosphates by brief treatment with toluene (permeablized) were used to measure the effect of the following chemical alkylating agents on either DNA replication or DNA repair synthesis: methyl methanesulfonate (MMS), ethyl methanesulfonate (EMS), N-methyl-N-nitrosourea (MNU), N-ethyl-N-nitrosourea (ENU), N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) and N-ethyl-N'-nitro-N-nitrosoguanidine (ENNG). Replication of DNA was completely inhibited 10 to 15 min after exposure to MMS at concentrations of 5 mM or higher or to MNU or MNNG at concentrations of 1 mM or higher. The ethyl derivatives of the alkylating agents were less inhibitory than their corresponding methyl derivatives, and inhibition of DNA replication occurred in the following order EMS < ENNG < ENU.

57181 **Field verification of cadmium toxicity to laboratory Daphnia populations.** Marshall, J.S. (Argonne National Lab., IL). *Bull. Environ. Contam. Toxicol.;* No. 20, 387-393(1978).

Studies were undertaken to compare the short-term toxicity of cadmium to laboratory populations of D. galeata mendotae with that to natural populations of D. galeata mendotae and total Daphnia in Lake Michigan, as indicated by its effects on the populations' rates of increase. Results indicate that short-term laboratory experiments using whole populations can be verified in the natural environment.

PLANTS

57182 **Photosynthesis and stomatal light responses in snap beans exposed to hydrogen sulfide and ozone.** Coyne, P.I.; Bingham, G.E.

(Univ. of California, Livermore). *J. Air Pollut. Control Assoc.;* **28**: No. 11, 1119-1123(Nov 1978).

Apparent photosynthesis and leaf stomatal conductance were measured in well watered, field grown snap beans (Phaseolus vulgaris L. cv GV50) fumigated with various levels of H_2S alone and in the presence of 0.072 ppM ozone. Mean concentrations of H_2S were 0, 0.74, 3.25, and 5.03 ppM. Plants were fumigated from 1000 to 1400 h (PDT) each day beginning at the first trifoliate leaf stage. The youngest fully expanded leaves were sampled after 18 +- 2 days of fumigation. The plants had 10 to 11 leaves and were flowering with about 80% of the flowers open. Hydrogen sulfide at 0.74 ppM increased maximum (max) stomatal conductance (C/sub max/) by 25% and maximum apparent photosynthesis (P/sub max/) by 10%. Higher concentrations of H_2S depressed stomatal opening and CO_2 uptake, and O_3 plus H_2S depressed stomatal and photosynthetic response more than H_2S alone. At the highest H_2S concentration plus O_3, C/sub max/ was 41%, and P/sub max/ was 52% of the control. Both C/sub max/ and P/sub max/ responded similarly to the 8 treatments but the difference between maximum and minimum responses was greater for conductance. As pollutant stress increased, photosynthesis ceased to respond linerarly to increasing conductance at lower conductance values indicating that mesophyll resistance to CO_2 transfer was more limiting than CO_2 diffusion through the stomata at higher light intensities. The initial slope of the curves of both conductance and photosynthesis as a function of irradiance decreased with increasing stress, suggesting decreased sensitivity to light. This indicates an increased sluggishness in the guard cells, which could be related to induced leaf senescence caused by the pollutants. It also indicates a loss of photochemical conversion efficiency resulting from loss of chlorophyll and development of necrotic areas on the leaves of the more stressed plants.

57183 Modelling solute uptake and incorporation into vegetation and litter. Luxmoore, R.J.; Begovich, C.L.; Dixon, K.R. (Oak Ridge National Lab., TN). *Ecol. Model.;* No. 5, 137-171(1978).

The concepts and algorithms of the Baldwin, Nye, and Tinker model describing solute movement from bulk soil solution into roots (DIFMAS) and a model of solute dynamics and accumulation in plant tissues and litter (DRYADS) are presented. Foliar uptake of solutes and gases are included in the DRYADS code. These models form components in a coupled system of models have hourly resolution of carbon, water, and solute dynamics in terrestrial ecosystems. Applications showing successive hourly, monthly, and annual results illustrate the utility of the models. The DRYADS model sensitivity to both leaf solute conductivity and root solute conductivity parameters suggest the importance of careful experimental determination of these plant properties. The tissues of solute entry (leaves, roots) initially accumulate solutes in a fixed form in preference to the more remote tissues (stems, fruits). Model application results show that root sapwood is the first major site of trace contaminant accumulation from soil-borne pollutants. The algorithms describing solute movement along a concentration gradient in phloem and as mass flow in the xylem transpiration stream result in high mobility of solutes in vegetation. The simulated diurnal pattern of root solute uptake showed that more than 85% of solutes were taken up during the daylight hours. The simulations further showed that contaminants had the greatest effect on the litter system. Toxic effects of contaminants on decomposition resulted in lower mineralization losses and accumulation of contaminant in litter with continuing deposition.

VERTEBRATES

REFER ALSO TO CITATION(S) 57127, 57189

57184 (CONF-790486—5) **Metabolic activation of carcinogens: an error in detoxification.** Selkirk, J.K.; MacLeod, M.C.; Cohen, G.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From Biology division research conference on the scientific basis of toxicity assessment; Gatlinburg, TN, USA (15 Apr 1979).

Metabolism kinetics and membrane interactions are reviewed to elucidate the movements of carcinogens into and through the cell's metabolic machinery. As with the example case of benzo(a)pyrene, the present calculations cannot accurately predict biochemical or carcinogenic activity since all the biochemical parameters necessary for prognostications are not yet known. (PCS)

57185 (CONF-790746—1) **Multistage chemical carcinogenesis in mouse skin.** Slaga, T.J.; Fischer, S.M.; Weeks, C.E.; Klein-Szanto, A.J.P. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 50p. Dep. NTIS, PC A03/MF A01.

From Japan-U.S. conference on normal and abnormal epidermal differentiation; Pellston, MI, USA (30 Jul 1979).

Skin tumors in mice can be induced by the sequential application of a subthreshold dose of a carcinogen (initiation phase) followed by repetitive treatment with a noncarcinogenic tumor promoter. The initiation phase requires only a single application of either a direct acting carcinogen or a procarcinogen which has to be metabolized before being active and is essentially an irreversible step which probably involves a somatic cell mutation. There is a good correlation between the skin tumor initiating activites of several polycyclic aromatic hydrocarbons (PAH) and their ability to bind covalently to epidermal DNA. Laboratory results suggest that bay region diol-epoxides are the ultimate carcinogenic form of PAH carcinogens. Potent inhibitors and stimulators of PAH tumor initiation appear to affect the level of the PAH diol-epoxide reacting with specific DNA bases. Reecent data suggests that the tumor promotion stage involves at least three important steps: (1) the induction of embryonic looking cells (dark cells) in adult epidermis; (2) an increased production of epidermal prostaglandins and polyamines; (3) sustained proliferation of dark cells. Retinoic acid specifically inhibits step two whereas the anti-inflammatory steriod fluocinolone acetonide is a potent inhibitor of steps one and three. The mechanism and the importance of a specific sequence for each step in chemical carcinogenesis in mouse skin are detailed.

57186 Effects of trace elements and mono- and dithiols on mitochondrial monoamine oxidase of rats. Revis, N.; Horton, C. (Oak Ridge National Lab., TN). *Toxicol. Appl. Pharmacol.;* **43**: 439-448(1978).

The effects of several trace elements on mitochondrial monoamine oxidase (MAO) were studied. Elements were studied at a concentration of 1 mM; only mercury, cadmium, and copper were significantly effective in reducing the activity of this enzyme. Of several thiols tested, only dithiothreitol could reverse the inhibition of MAO by these elements. Evidence is also presented in this report to show that cysteine, homocysteine, and reduced glutathione inhibit this MAO, whereas dithiothreitol or dithioerythritol evoke stimulatory responses.

57187 Base specificity in the binding of benzo[α]pyrene diol epoxide to Simian virus 40 DNA. Mengle, L.; Gamper, H.; Bartholomew, J. (Univ. of California, Berkeley). *Cancer Lett. (Amsterdam);* **5**: 131-137(1978).

Simian virus 40 (SV40)[^{14}C] DNA was reacted with [^{3}H]7β,8α-dihydroxy-9α,10α-epoxy-7,8,9,10-tetrahydrobenzo[α]pyrene to give 0.60 adducts per genome. The modified DNA was digested to completion with Hind III restriction endonuclease and the 6 fragments isolated by polyacrylamide gel electrophoresis. Hydrocarbon binding to the fragments was proportional to their guanine-cytosine (G-C) content, reflecting selective reaction of the hydrocarbon with deoxyguanosine residues. No sites unusually susceptible to alkylation were detected.

MAN

57188 (BNL—26481) **Some areas of basic research to identify genetic or carcinogenic effects.** Setlow, R.B. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-790752—1). Dep. NTIS, PC A02/MF A01.

From Workshop on the health effects of photovoltaic technology; Upton, NY, USA (31 Jul 1979).

Basic approaches to experiment planning are enumerated with the attendant limitations for interpreting the long term effects of various environmental agents on molecules, cells, tissues and animal test systems in order to relate to human populations, and how they might effect mutagenesis and carcinogenesis. (PCS)

57189 (PNL—2744) **Study of the combined effects of smoking and inhalation of uranium ore dust, radon daughters and diesel oil exhaust fumes in hamsters and dogs. Final report.** Cross, F.T.; Palmer, R.F.; Filipy, R.E.; Busch, R.H.; Stuart, B.O. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1 Sep 1978. Contract EY-76-C-06-1830. 143p. Dep. NTIS, PC A07/MF A01.

Exposure to particulates from uranium ore dust and diesel exhaust soot provoked inflammatory and proliferative responses in lungs. Also exposure to radon and radon daughters yielded increased occurrences of bronchiolar epithelial hyperplasia and metaplastic changes of alveolar epithelium. The data suggest that this cellular change is also a precursor of premalignant change in hamsters. The authors suggest an animal model other than the hamster based on two observations: (1) the Syrian golden hamster has been shown to be highly refractory to carcinoma induction; and (2) that when exposed to realistic levels of agents in life-span exposure regimens, the hamster does not develop lesions. Dog studies with cigarette smoke exposure showed mitigating effects on radon daughter induced respiratory tract cancer. Two reasons are suggested although no empirical evidence was gathered. A strict comparison of human and animal exposures and interpolative models are not possible at this time. (PCS)

57190 (UCRL-Trans—11461) **Further studies on the morphology of sperm from chronic alcoholics.** Semczuk, M.; Zrubek, H.; Czajka, R. Translated from *Pol. Tyg. Lek.;* **33**: No. 24, 961-964(1978). 10p. Dep. NTIS, PC A02/MF A01.

In 65 males with the diagnosis of chronic alcoholism and in 40 healthy fertile males serving as controls three morphological examinations of sperm were done. Depending on the duration of alcoholism the patients were divided into two groups: (1) 25 patients with a 10 to 15 year history of alcohol abuse, (2) 40 with a history of over 15 years of alcoholism. All patients and controls were in similar age groups. Morphological examinations of sperm were carried out according to generally accepted rules. The investigations confirmed a positive relationship between the duration of alcohol abuse and the progression of changes in the morphological pattern of the sperm. With longer duration of alcoholism the number of spermatozoa in 1 ml of sperm decreased, similarly there was a decrease in the proportion of active spermatozoa, and the proportion of spermatozoa of abnormal shape increased.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

57191 (AD-A—061947) **Biological effects of nonionizing electromagnetic radiation. Volume III. Number 2. Quarterly report, September-December 1978.** Kleinstein, B.H.; Saboe, E.P. (Franklin Research Center, Philadelphia, PA (USA). Science Information Services Organization). Dec 1978. Contract HO-A01-78-1157. 61p. NTIS PC A04/MF A01.

This quarterly digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (microwave and radio frequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, news items, and a directory of meetings and conferences.

57192 (EPRI-EA—1123) **Biological effects of high-voltage electric fields: an update. Volume 1. Final report.** (IIT Research Inst., Chicago, IL (USA)). Jul 1979. 224p. Dep. NTIS, PC A10/MF A01.

The objective of this project was to collect and review the literature which has become available since mid-1974 on the subject of biological effects of power frequency electric fields. The literature published prior to that date was reviewed as a part of a previous state-of-the-art review and program plan (EPRI RP-381-1). Some 2000 new entries of both publications and research programs in progress have been identified through a computer-aided literature search. Approximately 50 of these entries were selected by the authors of this update for in-depth consideration. This reduction was accomplished by considering only those entries that were deemed to be of direct interest, and by using several comprehensive and detailed reviews to guide the selection process. The general findings of this update confirm the conclusion of the 1975 review that it is highly improbable that electric fields from transmission lines have any significant biological effects on healthy individuals who encounter such fields in a normal way under ordinary conditions. However, further research is still needed in order to understand the nature and extent of any effects that could be harmful.

57193 (PB—290166) **A technical review of the biological effects of non-ionizing radiation.** (Office of Science and Technology Policy, Washington, DC (USA). Ad Hoc Working Group). 15 May 1978. 108p. NTIS PC A06/MF A01.

The report is a current statement designed to assist in the future development of a more formal long-term program. Discussions focused on radio-frequency radiation (RFR) and electro-magnetic fields associated with high-voltage transmission lines (HVTL). Sufficient data to define and amass human risk potential are not available as the research necessary would require a resource committment of a significant duration of time. Studies of interaction, long-term low level exposure, biological effects, and genetic effects are recommended.

HEALTH AND SAFETY

57194 (IDO—22058) **Probable hydrologic effects of a hypothetical failure of Mackay Dam on the Big Lost River valley from Mackay, Idaho, to the Idaho National Engineering Laboratory.** Druffel, L.; Stiltner, G.J.; Keefer, T.N. (National Space Technology Labs., NSTL Station, MS (USA)). Sep 1979. Contract W-7405-ENG-82. 53p. Dep. NTIS, PC A04/MF A01.

Mackay Dam is an irrigation reservoir on the Big Lost River, Idaho, approximately 7.2 kilometers northwest of Mackay, Idaho. Consequences of possible rupture of the dam have long concerned the residents of the river valley. The presence of reactors and of a management complex for nuclear wastes on the reservation of the Idaho National Engineering Laboratory (INEL), near the river, give additional cause for concern over the consequences of a rupture of Mackay Dam. A study was made to calculate and route the flood wave resulting from the hypothetical failure of Mackay Dam downstream to the INEL. Both a full and a 50 percent partial breach of this dam are investigated. Two techniques are used to develop the dam-break model. The method of characteristics is used to propagate the shock wave after the dam fails. The linear implicit finite-difference solution is used to route the flood wave after the shock wave has dissipated. The time of travel of the flood wave, duration of flooding, and magnitude of the flood are determined for eight selected sites from Mackay Dam, Idaho, through the INEL diversion. At 4.2 kilometers above the INEL diversion, peak discharges of 1502 and 1275 cubic meters per second and peak flood elevations of 1550.3 and 1550.2 meters were calculated for the full and partial breach, respectively. Flood discharges and flood peaks were not compared for the area downstream of the diversion because of the lack of detailed flood plain geometry.

57195 (SAND—79-1671C) **Role of systems safety in maintaining affordable safety in the 1980's.** Hollister, H.; Trauth, C.A. Jr. (Department of Energy, Washington, DC (USA); Sandia Labs., Albuquerque, NM (USA)). 10 Jul 1979. Contract EY-76-C-04-0789. 12p. (CONF-790703—2). Dep. NTIS, PC A02/MF A01.

From 4. international conference of the system safety society; San Francisco, CA, USA (9 Jul 1979).

Historically, the Department of Energy and its predecessors have used and supported the development of systems safety programs, practices, and principles, finding them by and large adequate, effective, and managerially efficient. Today, attempts are bing made to resolve increasingly complex environmental, safety, and health problems by turning to increasingly complex and detailed regulation as the primary governmental answer. It is increasingly doubtful that such an approach will provide management of these issues and problems that is either effective or efficient. Challenge is issued to those in systems safety to develop and apply systems safety principles and practices more broadly to total operational systems and not just to hardware and to environmental and health protection and not just to safety, so that the total universe of environmental, safety, and health can be managed effectively and efficiently with encouragement of innovation and creativity, using a relatively brief and concise, but adequate, regulatory base.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 56114, 56117

GEOPHYSICS

57196 **Earthquake Hazards Reduction Act of 1977.** Washington, DC; United States Senate (1977). 7p.

The text of a law to establish an earthquake hazards reduction program is presented. Reasons for such a program are cited. Objectives of the program include the following: the development of technologically and economically feasible construction methods and procedures to make new and existing structures earthquake resistant; the implementation of a system for predicting damaging earthquakes and identifying seismic hazards; the development of model codes to coordinate information about seismic risk with land-use policy decisions; improved understanding of earthquake-related issues; the education of the public as to earthquake phenomena; and research on ways to mitigate earthquake hazards, the consequences of earthquake prediction, and the availability of earthquake insurance; research leading to a better understanding of seismic phenomena. The research elements of the program are listed, and the implementation plan is set forth. (RWR)

SEISMOLOGY AND TECTONICS

57197 (NUREG/CR—0926) **Seismicity study of the Pacific Northwest region of the United States, November 1961—August 1965.** Racine, D. (Teledyne Geotech, Alexandria, VA (USA). Seismic Data Lab.). Jul 1979. 55p. NTIS.

This report is a seismicity study of the Pacific Northwest region of the United States; it covers the period between November 1961 and August 1965. During the study, 326 epicenters (SDL events) were located by visual analysis of film records of short-period seismic data. Magnitudes for these events ranged from 1.5 to 4.2, and were computed with a method that utilized vertical component L/sub g/ motion. This method was shown to be compatible with body-wave magnitudes. These SDL events were in addition to the 302 events in the area of interest, ranging in body-wave magnitude from 3.0 to 6.5, compiled from the National Earthquake Infor-

mation Service (NEIS) epicenter list. A plot of the 326 events generally shows the same geographic distribution as the plot of the NEIS events, except in Oregon, where most of the SDL events were located in the historically quiet SE quadrant of the state. Considerably more events were located in Washington and Oregon than appeared on the NEIS plot; hence, the area of interest is evidently far more active than traditionally thought. Geotech recommends that the Corps of Engineers refine locations, develop single-station location techniques, develop travel-time tables for the region, and investigate depth determinations. 7 figures, 17 tables.

57198 (UCRL—15079) **Seismic risk analysis for the Exxon Nuclear Plutonium Facility, Richland, Washington.** (TERA Corp., Berkeley, CA (USA)). 29 Sep 1978. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

The results of a detailed seismic risk analysis of the Exxon Nuclear Plutonium Facility at Richland, Washington, are presented. The historical seismic record used in this analysis is the most current and complete available. The record, which is a synthesis of data from the University of Washington Puget Sound Array, the Eastern Washington Array, and the NEIS data bases, was provided by Battelle Northwest, Richland. The resulting seismic record, covering the period 1833-1977, was used to identify all possible sources of seismicity that could affect the site. Inadequacies and incompleteness in this record were explicitly considered in the definition of source regions and their activity rates. Where there were uncertainties, we assigned subjective probabilities to the span of uncertainty. The acceleration attenuation relation used in the analysis was developed based on a careful evaluation of all relevant strong motion data. To guarantee use of the best available calculational methods and input, the entire project was reviewed by Professor Stewart W. Smith, a University of Washington seismologist, well known for his research on west coast seismicity and tectonics. The results of our analysis, which include estimates of the uncertainty, are presented graphically. Our best estimate curve indicates that the Exxon facility will experience 10 percent g with a return period of 600 years and 15 percent g with a return period of 2,500 years. The curves on either side of our best estimates represent roughly the one standard deviation confidence limits about this best estimate. These curves provide the seismic design basis for the Exxon facility in terms of peak ground acceleration. For those structures and equipment that could experience structural amplification, we judge that the mean alluvium response spectrum prescribed in WASH 1255 (AEC, 1973) adequately characterizes the frequency content.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 56124

57199 (RHO-BWI-C—50) **Determination of basalt physical and thermal properties at varying temperatures, pressures, and moisture contents. First progress report, fiscal year 1979.** Miller, R.J.; Bishop, R.C. (Colorado School of Mines, Golden (USA). Evacuation Engineering and Earth Mechanics Inst.). 26 Mar 1979. Contract EY-77-C-06-1030. 83p. Dep. NTIS, PC A05/MF A01.

This report is a summary of the rock mechanics testing done at the Earth Mechanics Institute of the Colorado School of Mines for Rockwell Hanford Operations under Subcontract SA-917. Cores were supplied from drill hole DC-6 on the Hanford Site, characterized geologically, and tested for thermal and physical properties for designing long-term underground storage of radioactive waste materials. This report presents the approved test procedures, results, and data analysis for this test series. Results indicated thermophysical properties similar to those of previously tested basalt cores from the Hanford area, but showed no significant trends; thus, generalizations are risky at this time. However, density was found to be a good guide to thermal and physical properties--higher density basalt cores showed significant improvements in physical and thermal properties.

OCEANOGRAPHY

57200 **Deep seas: climate and economic development.** Gibrat, R. pp 291-299 of Carbon dioxide, climate, and society. Williams, J. (ed.). Elmsford, NY; Pergamon Press Inc. (1978).

From IIASA carbon dioxide, climate and society workshop; Laxenburg, Austria (21 Feb 1978).

Studies on oceanographic mechanisms are reviewed. The importance of greater understanding of these mechanisms is important, especially with serious consideration being given to using the oceans for CO_2 nd thermal discharges, as well as the thermal gradients as an energy source. (JGB)

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

57201 (LA-UR—79-2383) **Acceleration mechanisms flares, magnetic reconnection and shock waves.** Colgate, S.A. (Los Alamos Scientific Lab., NM (USA)). 23 Aug 1979. Contract W-7405-ENG-36. 15p. (CONF-790870—1). Dep. NTIS, PC A02/MF A01.

From International astronomical union meeting; Montreal, Canada (20 Aug 1979).

Several mechanisms are briefly discussed for the acceleration of particles in the astrophysical environment. Included are hydrodynamic acceleration, spherically convergent shocks, shock and a density gradient, coherent electromagnetic acceleration, the flux tube origin, symmetries and instabilities, reconnection, galactic flares, intergalactic acceleration, stochastic acceleration, and astrophysical shocks. It is noted that the supernova shock wave models still depend critically on the presupernova star structure and the assumption of highly compact presupernova models for type I supernovae. 37 references. (JFP)

57202 (N—79-13978) **Research on lunar materials. Final technical report.** Gold, T. (Cornell Univ., Ithaca, NY (USA). Center for Radiophysics and Space Research). Sep 1978. Contract NGR-33-010-137. 11p. NTIS PC A02/MF A01.

Abstracts of 14 research reports relating to investigations of lunar samples are presented. The principal topics covered include: (1) optical properties of surface and core samples; (2) chemical composition of the surface layers of lunar grains: Auger electron spectroscopy of lunar soil and ground rock samples; (3) high frequency electrical properties of lunar soil and rock samples and their relevance for the interpretation of lunar radar observations; (4) the electrostatic dust transport process; (5) secondary electron emission characteristics of lunar soil samples and their relevance to the dust transportation process; (6) grain size distribution in surface soil and core samples; and (7) the optical and chemical effects of simulated solar wind (2keV proton and α particle radiation) on lunar material.

57203 (UCRL—83295) **Preferential acceleration in collisionless supernova shocks.** Hainebach, K.; Eichler, D.; Schramm, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Sep 1979. Contract W-7405-ENG-48. 7p. (CONF-790836—5). Dep. NTIS, PC A02/MF A01.

From 16. international cosmic rays conference; Kyoto, Japan (6 Aug 1979).

The preferential acceleration and resulting cosmic ray abundance enhancements of heavy elements (relative to protons) in the collisionless supernova shock acceleration model described by Eichler in earlier work are calculated. Rapidly increasing enhancements up to several tens times solar ratios are obtained as a function of atomic weight over charge at the time of acceleration. For material typical of hot phase interstellar medium, good agreement is obtained with the observed abundance enhancements. 13 references.

STARS

57204 **2A 0526-328: An X-ray—emitting cataclysmic variable.** Charles, P.; Thorstensen, J.; Bowyer, S.; Middleditch, J. (Space Sciences Laboratory and Department of Astronomy, University of California, Berkeley). *Astrophys. J., Lett.;* **231**: No. 3, L131-L135(1 Aug 1979).

We identify the weak hard X-ray source 2A 0526—328 with a previously unknown cataclysmic variable on the basis of its optical emission-line spectrum and a precise X-ray location. This V ~ 14 mag star has spectral properties similar to dwarf novae at minimum light and AM Her, but shows no polarization. It is likely to be a Z Camelopardalis-type system in a very extended stand-still (i.e., "nova-like" or UX Ursae Majoris—type) or a recurrent nova that has not erupted in recent times.

57205 (LA-UR—79-2611) **PG1159-035: a new, hot, non-DA pulsating degenerate.** McGraw, J.T.; Starrfield, S.G.; Liebert, J.; Green, R. (Los Alamos Scientific Lab., NM (USA); Arizona Univ., Tucson (USA); California Inst. of Tech., Pasadena (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790755—3). Dep. NTIS, PC A02/MF A01.

From IAU colloquium on the structure of white dwarfs and variable degenerates; Rochester, NY, USA (30 Jul 1979).

The star was observed with a computer-controlled high-speed photometer. The light curve showed nearly sinusoidal variations with a period of about 8 minutes and a peak-to-peak amplitude of about 0.02 magnitude. Power spectra of the light curves were calculated. They showed peaks corresponding to periods of 460 and 539 seconds. The effective temperature of the star was found to exceed 5×10^4 K; lack of circular polarization indicated that the star

does not have a large surface magnetic field. The surface gravity is indeterminate, but probably lower than log g = 8. It is suggested that this star is pulsating in some manner; it is likely to change rapidly. 3 figures. (RWR)

57206 (N—79-13959) **The eight micron band of silicon monoxide in the expanding cloud around VY Canis Majoris.** Geballe, T.R.; Lacy, J.H.; Beck, S.C. (Hale Observatories, Pasadena, CA (USA)). 1978. Contracts NGL-05-003-272;NSF-AST-77-12256. 21p. NTIS PC A02/MF A01.

Observations of vibration-rotation transitions of silicon monoxide in VY CMa show that the lines originate in accelerating, expanding, and cool (600 K) layers of a circumstellar cloud at a distance of roughly 0.15 minutes from the central star. The central stellar velocity, as estimated from observed SiO P Cygni line profiles, is somewhat redshifted from the midpoint of the maser emission features. Most of the silicon is proabably in the form of dust grains. The isotopic ratios of silicon are nearly terrestrial.

57207 (N—79-13960) **Observation of the 63 micrometer (O I) emission line in the Orion and Omega Nebulae.** Melnick, G.; Gull, G.E.; Harwit, M. (Cornell Univ., Ithaca, NY (USA). Center for Radiophysics and Space Research). Jul 1978. Contract NGR-33-010-146. 25p. NTIS PC A02/MF A01.

The 63 micrometer fine structure transition P4 : 3Pl → 3P2 for neutral atomic oxygen was obtained during a series of flights at an altitude of approximately 13.7 km. In the Orion Nebula (M42), the observed line strength was 8 x 10^{-15} W/cm^2, which is estimated to be approximately 0.3 o/o of the energy radiated at all wavelengths. For the Omega Nebulae (M17), the line strength was 2.4 x 10^{-15} W/cm^2, and the fraction of the total radiated power was slightly higher. These figures refer to a 4' x 6' field of view centered on the peak for infrared emission from each source. The uncertainty in the line strength is approximately 50% and is caused by variable water vapor absorption along the flight path of the airplane. The line position estimate is 63.2 (+0.1, -0.2) micrometer. The prime uncertainty is due to the uncertain position of the (0 I) emitting regions in the field of view.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

57208 (N—79-13838) **Nuclear gamma rays from energetic particle interactions.** Ramaty, R.; Kozlovsky, B.; Lingenfelter, R.E. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Sep 1978. 133p. NTIS PC A07/MF A01.

Gamma ray line emission from nuclear deexcitation following energetic particle reactions is evaluated. The compiled nuclear data and the calculated gamma ray spectra and intensities can be used for the study of astrophysical sites which contain large fluxes of energetic protons and nuclei. A detailed evaluation of gamma ray line production in the interstellar medium is made.

57209 (N—79-13968) **Topics in astrophysical x ray and gamma ray spectroscopy.** Bussard, R.W. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Nov 1978. Contract NGR-21-002-316. 131p. NTIS PC A07/MF A01.

Thesis. Submitted to Maryland Univ.

A number of topics relating to astrophysical observations that have already been made or are currently planned of spectral features, mostly emission lines, in the x ray and gamma ray region of the electromagnetic spectrum are investigated. These topics include the production of characteristic x ray and gamma ray lines by nonthermal ions, spectral features induced by processes occurring in strong magnetic fields, and the positron annihilation line at 0.5 MeV. The rate of x-ray production at 6.8 keV by the 2p to 1s transition in fast hydrogen- and helium-like iron ions, following both electron capture to excited levels and collisional excitation, is calculated. The cross section for electron-ion Coulomb collisions in strong fields is also calculated.

SOLAR PHENOMENA

57210 (N—79-13985) **Spectral evolution of multiply-impulsive solar bursts.** Karpen, J.T.; Crannell, C.J.; Frost, K.J. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Nov 1978. 29p. NTIS PC A02/MF A01.

Thesis. Submitted to Maryland Univ.

Hard X-ray and microwave observations of multiply-impulsive solar bursts, identified in the OSO-5 data, were analyzed. Spectra in both frequency ranges were used to determine whether or not the source properties change from peak to peak within individual bursts. Two categories of microwave spectral behavior were identified: those events during which the microwave turnover frequency and spectral shape remain the same from peak to peak, and those during which the turnover frequency and spectral shape change significantly. These categories correspond to two classes of multiply-impulsive bursts: those for which the emission can be characterized by a constant magnetic field and therefore a single source region, in which case the multiplicity may be due to modulation of the emission process; and those in which groups of component spikes appear to originate in regions of different magnetic-field strengths, corresponding to separate source regions which flare sequentially. Examples of the latter type of events are presented. The discrete flaring regions are analyzed, and their spatial separations, estimated.

57211 **Solar output and its variation.** White, O.R. (ed.). Boulder, CO; Colorado Associated University Press (1977). 535p. (CONF-7604163—). The Publisher, 1424 15th Street, Boulder, CO 80309.

From The solar output and its variation workshop; Boulder, CO, USA (26 Apr 1976).

Topics covered include: historical and paleological evidence for solar variability; the integrated solar flux; the solar spectrum; the solar plasma and energetic particles; the theory of the solar variation; and stellar variability. (GHT)

GALAXIES

REFER ALSO TO CITATION(S) 57208

57212 (N—79-13961) **The 51.8 micrometer (O III) line emission observed in four galactic H2 regions.** Melnick, G.; Gull, G.E.; Harwit, M. (Cornell Univ., Ithaca, NY (USA). Center for Radiophysics and Space Research). Aug 1978. Contract NGR-33-10-146. 21p. NTIS PC A02/MF A01.

The (O III) 51.8 micrometer line from four H II regions, M42, M17, W51, and NGC 6375A, was detected. Respective line strengths are 7 x 10^{-15}, 1.0 x 10^{-14}, 2.1 x 10^{-15} and 2.6 x 10^{-15} W/cm^2. Observations are consistent with previously reported line position and place the line at 51.80 +- 0.05 micrometers. When combined with the 88.35 micrometer data (O III) reported earlier, clumping seems to be an important factor in NGC 6375A and M42 and to a lesser extent in W51 and M17. The combined data also suggest an (O III) abundance of approximately 3 x 0.0001 sub n e' a factor of 2 greater than previously assumed.

57213 (N—79-13967) **Tholins: organic chemistry of interstellar grains and gas.** Sagan, C.; Khare, B.N. (Cornell Univ., Ithaca, NY (USA). Lab. for Planetary Studies). Sep 1978. Contract NGR-33-010-101. 27p. NTIS PC A03/MF A01.

A complex organic solid produced from cosmically abundant molecules explains many properties of the interstellar grains and gas. The product, a brown, sometimes sticky residue that is resistant to conventional analytic chemistry, has been named tholins and is discussed as a major consituent of the interstellar medium. Sequential and nonsequential pyrolysis followed by gas chromatography/mass spectroscopy were used to determine something of the composition of this material. The production and properties of tholins produced by spark discharges and by ultraviolet light are examined.

57214 **Double galaxies. I. Observational data on a well-defined sample.** Peterson, S.D. (National Radio Astronomy Observatory, Charlottesville, Virginia). *Astrophys. J., Suppl. Ser.;* **40**: No. 3, 527-575(Jul 1979).

A sample including 279 binary galaxies over a wide range of separations is selected from the Uppsala general catalog using well-defined criteria. The true angular separation distribution of the binary galaxies is reconstructed from the observed distribution and a statistical analysis of the selection criteria. Observational data are complied on the galaxies using optical as well as radio information. The associated 21 cm neutral-hydrogen studies result in the detection of 149 member galaxies (94 without observed optical redshifts). In addition to accurate radial velocities, H I studies provide global measurements on individual galaxies, including total indicative mass and mass-to-light ratios, to be compared with values obtained from a statistical study of the orbital parameters.

COSMOLOGY

REFER ALSO TO CITATION(S) 57294

PLANETARY PHENOMENA

REFER ALSO TO CITATION(S) 57202, 57376

57215 (N—79-13969) **Intense magnetic fields at 1 AU: solar cycle 20.** Burlaga, L.F.; King, J.H. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Nov 1978. 33p. NTIS PC A03/MF A01.

Of the intense magnetic fields (greater than 13 gamma) observed at 1 AU during solar cycle 20 (1973-1975), 92% were associated with shocks, stream interfaces, or cold magnetic enhancements (CMEs). Most (52%) of the magnetic field intensity enhancements occurred at stream interfaces; 27% occurred behind shocks without interfaces; and 11% occurred in CMEs. The most intense

fields (25 gamma to 37 gamma) followed shocks. Magnetic field intensities at interfaces did not exceed 25 gamma, suggesting a mechanism such as a magnetoacoustic wave limits the intensity ahead of streams. Intense magnetic fields persist longest behind shocks.

57216 (N—79-13972) **Significant achievements in the planetary geology program. Final report.** Head, J.W. (Brown Univ., Providence, RI (USA). Dept. of Geological Sciences). Dec 1978. 61p. NTIS PC A04/MF A01.

Developments reported at a meeting of principal investigators for NASA's planetology geology program are summarized. Topics covered include the following: constraints on solar system formation; asteriods, comets, and satellites; constraints on planetary interiors; volatiles and regoliths; instrument development techniques; planetary cartography; geological and geochemical constraints on planetary evolution; fluvial processes and channel formation; volcanic processes; Eolian processes; radar studies of planetary surfaces; cratering as a process, landform, and dating method; and the Tharsis region of Mars. Activities at a planetary geology field conference on Eolian processes are reported and techniques recommended for the presentation and analysis of crater size-frequency data are included.

57217 (N—79-13973) **Interdisciplinary investigations of comparative planetology. Annual status report, 1 October 1977-30 September 1978.** Sagan, C. (Cornell Univ., Ithaca, NY (USA). Lab. for Planetary Studies). 1 Sep 1978. Contract NGR-33-010-220. 18p. NTIS PC A02/MF A01.

Research supported wholly or in part by NASA's Planetary Programs Office is summarized. Topics covered include: the evaporation of ice in planetary atmospheres: ice-covered rivers on Mars; reducing greenhouses and the temperature history of Earth and Mars; particle motion on Mars inferred from the Viking Lander cameras; the nature and visibility of crater-associated streaks on Mars; the equilibrium figure of Phobos and other small bodies; striations on Phobos; radiation pressure and Poynting-Robertson drag for small spherical particles; direct imaging of extra-solar planets with stationary occultations; the relation between planetology and conventional astrophysics; remote spectral studies and in situ X-ray fluorescence analysis of the Martian surface; small channels on Mars; junction angles of Martian channels; constraints on Aeolian phenomena on Mars; the geology of Mars; and the flow of erosional debris on the Martian terrain.

57218 (N—79-13975) **Temperature structure and emergent flux of the Jovian planets.** Silvaggio, P.; Sagan, C. (Cornell Univ., Ithaca, NY (USA). Lab. for Planetary Studies). Oct 1978. Contract NGR-33-010-082. 60p. NTIS PC A04/MF A01.

Long path, low temperature, moderate resolution spectra of methane and ammonia, broadened by hydrogen and helium, are used to calculate non-gray model atmospheres for the four Jovian planets. The fundamental and first overtone of hydrogen contributes enough absorption to create a thermal inversion for each of the planets. The suite of emergent spectral fluxes and representative limb darkenings and brightenings are calculated for comparison with the Voyager infrared spectra. The temperature differences between Jovian belts and zones corresponds to a difference in the ammonia cirrus particle radii (1 to 3 micron in zones; 10 micron in belts). The Jovian tropopause is approximately at the 0.1 bar level. A thin ammonia cirrus haze should be distributed throughout the Saturnian troposphere; and NH3 gas must be slightly supersaturated or ammonia ice particles are carried upwards convectively in the upper troposphere of Saturn. Substantial methane clouds exist on both Uranus and Neptune. There is some evidence for almost isothermal structures in the deep atmospheres of these two planets.

ATMOSPHERIC PHYSICS

MAGNETOSPHERIC PHENOMENA

57219 (N—79-13224) **Vlf wave-wave interaction experiments in the magnetosphere.** Chang, D.C.D. (Stanford Univ., CA (USA). Radioscience Lab.). May 1978. Contracts NGL-05-020-008;NSF DPP-76-82646. 210p. NTIS PC A10/MF A01.

VLF wave-wave interaction experiments were carried out by injecting various forms of VLF pulses into the magnetosphere from a 21.2 km dipole antenna at Siple, Antarctica. The injected signals propagate along a geomagnetic field line and often interact strongly with energetic electrons trapped in the radiation belts near the equator. Signals may be amplified and trigger emissions. These signals may then interact with one another through these energetic electrons. This report is divided into three parts. In the first part, simulations of VLF pulses propagating in the magnetosphere are carried out. In the second part, it is found for the first time that a 10 ms gap in a triggering wave can induce emission, which may then interact with the post-gap signals. In the third part, sideband triggering is reported for the first time.

57220 (N—79-13609) **Magnetospheric electrostatic emissions and cold plasma densities.** Hubbard, R.F.; Birmingham, T.J. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Oct 1978. 43p. NTIS PC A03/MF A01.

A synoptic study of electric wave, magnetometer, and plasma data from IMP-6 was carried out for times when banded electrostatic waves are observed between harmonics of the electron gyrofrequency in the earth's outer magnetosphere. Four separate classes of such waves were previously identified. The spatial and temporal occurrences of waves in each class are summarized here, as are correlations of occurrence with geomagnetic activity. Most importantly, associations between the observations of waves of different classes and the relative portions of cold and hot electrons present at the position of the spacecraft are established. Finally, evidence for the signature of the loss cone is sought in the plasma data.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

57221 **Diffusion-controlled chemical reactions modeled by continuous-time random walks.** Helman, W.P.; Funabashi, K. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *J. Chem. Phys.;* **71**: No. 6, 2458-2463(15 Sep 1979).

In the kinetic theory of pseudo-first-order diffusion-controlled chemical reactions, the diffusion motion of one component can be suppressed as long as the relative diffusion coefficient is assigned to the other component. The continuous-time-random-walk (CTWR) treatment of the pseudo-first-order reactions reaffirmed this well-known notion in the case of an exponential jump time distribution. In the case of a long-tail jump time distribution of Scher—Montroll, the decay dynamics depends upon which component is assigned the role of random walker, especially at low survival fractions.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 57040, 57226, 57227, 57245, 57246, 57247, 57249

57222 (CONF-790843—4) **Neutral hydrogen from the foil-induced dissociation of $^4HeH^+$, $^3HeH^+$, and H_3^+.** Cooney, P.J.; Gemmell, D.S.; Kanter, E.P.; Pietsch, W.J.; Zabransky, B.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From 8. international conference on atomic collisions in solids; Hamilton, Canada (13 Aug 1979).

High resolution energy spectra and angular distributions of H^0 from the dissociation of $^4HeH^+$, $^3HeH^+$, and H_2^+ in thin carbon foils are presented for incident ion energies ranging from 170 to 1800 keV/amu. For the range of dwell times inside the target foils studied (about 1 to 10 fsec), the dominant mechanism for such dissociation is the Coulomb explosion of the ions inside the target followed by electron capture near the rear surface of the foil. At the shortest of these dwell times, the yield of H^0 for incident ions oriented perpendicular to the beam relative to that for ions aligned with the beam is a factor of two greater than at longer dwell times. These data indicate that, for ion fragments which emerge from the rear surface of the target within a few angstroms of one another, those in the perpendicular orientation have a greater electron capture probability than those emerging in other orientations. 9 references.

57223 (CONF-790861—2) **Coincidence experiments concerning forward electron ejection.** Sellin, I.A.; Suter, M.; Vane, C.R.; Elston, S.B.; Thoe, R.S.; Alton, G.D. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 2p. Dep. NTIS, PC A02/MF A01.

From 11. international conference on the physics of electronic and atomic collisions; Kyoto, Japan (29 Aug 1979).

Several promising advantageous techniques of particular importance for coincidence experiments concerning the forward electron ejection in He and proton collisions with atoms and solids are discussed including high gain amplification of small electron energy intervals, solution of formidable detection problems, a gain in high detection efficiency, and the minimization of spread and their consequent advantages for particular experiments. The coincidence arrangement is discussed and shown schematically. 8 references. (JFP)

57224 (LBL—9596) **Surface and adsorbate structural studies by photoemission in the $h\nu$ = 50-500 eV range.** Shirley, D.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Chemistry). Aug 1979. Contract W-7405-ENG-48. 49p. (CONF-790878—1). Dep. NTIS, PC A03 MF/A01.

From International summer institute on surface science; Milwaukee, WI, USA (13 Aug 1979).

The present status of photoelectron spectroscopy in the 50-500 eV range is discussed in relation to its application to surface

science. Instrumentation aspects of synchrotron radiation sources are reviewed. The direct transition model is shown to be applicable in this range with some limitations. Cooper minima and adsorbate sensitivity enhancement for $h\nu > 100$ eV are reviewed. A new effect--condensed phase photoelectron asymmetry--is noted. Finally, photoelectron diffraction - another new effect - is described and evaluated.

57225 Temperature- and photon-energy-induced breakdown of the direct transition model in Cu. Stoehr, J.; Williams, R.S.; Wehner, P.S.; Shirley, D.A. Berkeley, CA; Univ. of California (1978). 4p.

The first experimental demonstration that the photoemission cross section contains a Debye-Waller factor which favors phonon-assisted (or indirect) transitions for both high photon energies and high temperatures is presented.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 56979, 57245, 57246, 57247, 57249

57226 (CONF-790843—3) **Measurement of the distributions of internuclear separations in 3.0-MeV H_2^+ and 3.63-MeV HeH^+ beams.** Kanter, E.P.; Cooney, P.J.; Gemmell, D.S.; Vager, Z.; Pietsch, W.J.; Zabransky, B.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From 8. international conference on atomic collisions in solids; Hamilton, Canada (13 Aug 1979).

Angular distributions of charged dissociation fragments are measured for 3.0-MeV H_2^+ and 3.63-MeV HeH^+ ions incident on ~ 160 A carbon targets. By using the reflection method for a pure Coulomb potential, there are unfolded from these data the distributions of internuclear separations for each molecular-ion species prior to dissociation. These results are insensitive to ion-source conditions. For H_2^+ this distribution, while ~ 2 times wider than a pure ground vibrational state population, is markedly different from the Franck-Condon distribution that has been previously assumed by other authors with similar rf and duo-plasmatron ion sources. For HeH^+ the distribution is slightly broader (~ 1.5 times) than that expected for a pure ground state population. From the data, the initial vibrational state population in the incident beam can be extracted. 11 references.

57227 (CONF-790843—6) **Experimental confirmation of the Jahn-Teller distortion of CH_4^+.** Gemmell, D.S.; Kanter, E.P.; Pietsch, W.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 8. international conference on atomic collisions in solids; Hamilton, Canada (13 Aug 1979).

Measured energy and angular distributions are reported for H^+ and C/sup n+/ (n = 2,3,4) fragments resulting from the collisional dissociation of 200-keV/amu CH/sub m/$^+$ (m = 0 to 4) in thin carbon targets. From the systematic trends of these Coulomb explosion spectra, qualitative information can be obtained on the structures of these species. In particular, the series displays a narrowing of the carbon angular and energy widths as protons are symmetrically added around a central carbon atom and provide a focusing effect. Because of the Jahn-Teller distortion, the carbon width in CH_4^+ is dramatically increased. 8 references.

57228 (INIS-mf—4754(No.4), pp 43-45) **Theoretical studies of the transition probabilities for the $2s^22p^2$-$2s2p^3$-$2p^4$ levels of the Ca XV and Fe XXI ions.** Bogdanovich, P.O.; Merkelis, Y.V.; Rydeikas, E.B.; Shadzhuvene, S.D. (Institute of Physics of Lith. S.S.R., Vilnius, USSR); Safronova, U.I. (AN SSSR, Moscow. Inst. Spektroskopii). Apr 1978.

In International bulletin on atomic and molecular data for fusion. No.4.

57229 (UCID—18167) **Scaled hydrogenic approximation wavefunctions.** Shore, B.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Although widespread use of computer codes for the solution of Schrodinger equations makes available numerical Hartree-Fock model radial wave functions, there remains persistant interest in simple analytic expressions for atomic wave functions. One such frequency favored approach employs hydrogenic functions, suitably scaled, as approximate wave functions. The following note displays typical inaccuracies to be expected from such approximations. 13 references.

57230 (UCRL—82994) **Collisional relaxation of low lying electronically excited states of uranium: $f^3ds^2(^5K_5^0)$ and $(^5L_7^0)$.** Chen, H.L.; Borzileri, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Jun 1979. Contract W-7405-ENG-48. 18p. (CONF-791035—1). Dep. NTIS, PC A02/MF A01.

From 32. annual gaseous electronic conference; Pittsburgh, PA, USA (9 Oct 1979).

Laser induced fluorescence techniques were used to measure the rates of electronic relaxation of atomic uranium in a beam-gas scattering apparatus. Cross sections for the collisional deactivation of the U $f^3ds^2(^5K_5^0)$ and $(^5L_7^0)$ states by H_2, D_2, HD, CH_4, N_2, and CO at room temperature are reported. Upper limits for quenching cross sections with He were also obtained. Relaxation of these uranium metastables by molecular hydrogen (H_2, D_2 and HD) and methane appears to proceed by resonant electronic-to-rotational or electronic-to-vibration/rotational energy transfer processes. 12 references.

57231 Temperature dependence of ^{23}Na asymmetry parameter in beta-alumina: "Trapped" vs "free" sodium. Polak, M.; Vaughan, R.W. (Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, California 91125). *J. Chem. Phys.;* **71**: No. 7, 3141-3142(1 Oct 1979).

^{23}Na nuclear magnetic resonance results of Cheung, et al and Bailey, et al are interpreted in the light of model given by Wolf. (AIP)

57232 PES of higher temperature vapors: Lithium halide monomers and dimers. Berkowitz, J.; Batson, C.H.; Goodman, G.L. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **71**: No. 6, 2624-2636(15 Sep 1979).

The He (I) photoelectron spectra of "pure" monomers and dimers of the lithium halides have been obtained by using a double-oven technique to vary the dimer:monomer ratio. The lithium halide monomer spectra conform nicely to a model based on spin—orbit and ligand field interactions previously introduced. The first ionization potentials of the dimers are in each case higher than in the corresponding monomers. These conclusions are also deduced in this paper by ionic model calculations and molecular calculations of the X-α type, using the discrete variational method. The X-α calculations enable us to assign tentatively the dimer valence bands. These calculations have been extended to trimer and tetramer structures and indicate an oscillation in the first ionization potential in the series encompassing monomer through tetramer. Some experimental verification exists up to trimer. The oscillatory behavior is also obtained in a crude ionic model calculation. An experimental method using photoionization mass spectrometry is suggested for the study of larger clusters and is tested for Na_2I_2.

57233 K-shell photoabsorption coefficients of O_2, CO_2, CO, and N_2O. Barrus, D.M.; Blake, R.L.; Burek, A.J.; Chambers, K.C.; Pregenzer, A.L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **20**: No. 3, 1045-1061(Sep 1979).

The total photoabsorption coefficient has been measured from 500 to 600 eV around the K edge of oxygen in gases O_2, CO_2, CO, and N_2O by means of a gold continuum source and crystal spectrometer with better than 1-eV resolution. The cross sections are dominated by discrete molecular-orbital transitions below the K-edge energy. A few Rydberg transitions were barely detectable. Broad shape resonances appear at or above the K edge. Additional broad, weak features above the K edge possibly arise from shake up. The authors give quantitative results that have about 10% accuracy (3σ), except on the very strong peaks. All the measured features are discussed in relation to other related measurements and theory.

57234 (UCRL-Trans—11502) **Contribution to the study of highly excited states of the uranium atom.** Blancard, P. (Paris-11 Univ., 91 - Orsay (France)). Aug 1979. Translation of thesis presented at the Univ. of Paris, Orsay, France (Chapts. 2 and 3 only), 1979. 33p. Dep. NTIS, PC A03/MF A01.

The study of the uranium atom highly excited states covers the spectra, and its analysis, and the valence and Rydberg states. A detailed theoretical development is presented. (JFP)

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 57223, 57230

57235 (CONF-790861—1) **Introductory remarks on electron capture by multicharged ions.** Crandall, D.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A02/MF A01.

From 11. international conference on the physics of electronic and atomic collisions; Kyoto, Japan (29 Aug 1979).

An overview is presented of applications of multicharged-ion electron capture and, through the qualitative assessment of availability of information, the general status of current understanding of such capture. A chart is given on which the various ion collision processes are related to other pertinent fields of physical research notably fusion, astrophysics, the solar corona, and lasers. The production and transport of ions is also noted. The symposium considers collision velocities less than 4×10^8 cm/s, where the capture cross sections are largest and where most of the available results are quite recent. (JFP)

57236 (CONF-790861—3) **K-Auger electrons observed in coincidence with final projectile charge state in ion-atom collisions.** Suter, M.; Vane, C.R.; Elston, S.B.; Sellin, I.A.; Thoe, R.S.; Alton, G.D. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 2p. Dep. NTIS, PC A02/MF A01.

From 11. international conference on the physics of electronic and atomic collisions; Kyoto, Japan (29 Aug 1979).

Coincidence techniques were used to study K-Auger electrons as a function of the initial and final charge states for C/sup q+/ and O/sup q+/ projectiles in Ar and Ne targets under single collision conditions. As an example some electron spectra for C^{2+} at 18.75 MeV on Ar are discussed in more detail. The coincidence spectra with the final charge states four and five are shown together with the corresponding spectra of the noncoincident events observed in the same runs. 3 references. (JFP)

57237 (CONF-790861—4) **Target dependences for continuum capture processes in ion-atom collisions.** Vane, C.R.; Sellin, I.A.; Suter, M.; Elston, S.B.; Alton, G.D.; Thoe, R.S.; Laubert, R. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA); East Carolina Univ., Greenville, NC (USA)). 1979. Contract W-7405-ENG-26. 2p. Dep. NTIS, PC A02/MF A01.

From 11. international conference on the physics of electronic and atomic collisions; Kyoto, Japan (29 Aug 1979).

By using bare and few-electron ions of higher charge on heavier targets, some fundamental aspects of continuum capture which had previously been obscured due to limitations imposed by high direct ionization backgrounds are examined. Beams of 1.6 to 3.9 MeV/u C^{6+}, O^{8+}, and Si^{14+} were passed through thin targets of helium, neon, and argon. The electrons ejected within a forward cone of half-angle about 1.8° were energy analyzed with data collected using standard multi-scaling techniques. The yields, defined by numerical integration over suitably scaled limits, show several interesting properties which are discussed, notably the velocity dependence. 5 references. (JFP)

57238 (CONF-790861—6) **Shape-resonance-enhanced nuclear motion effects in electron-molecule scattering and molecular photoionization.** Dehmer, J.L.; Dill, D. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From 11. international conference on the physics of electronic and atomic collisions; Kyoto, Japan (29 Aug 1979).

Shape resonances in the electronic continuum of molecules induce strong coupling between vibrational and electronic motion over a spectral range much broader than the resonance half width. In photoionization, this coupling causes large deviations from Franck-Condon intensity distributions and strong dependence of photoelectron angular distributions on the vibrational state of the residual ion. In electron scattering, it enhances vibrational excitation. Recent work is reviewed in which new, observable manifestations of this coupling were predicted theoretically and then verified experimentally. 67 references.

57239 (CONF-790882—1) **Applications of resonance ionization spectroscopy to ultralow-level counting and mass spectroscopy.** Kramer, S.D.; Hurst, G.S.; Young, J.P.; Payne, M.G.; Kopp, M.K.; Callcott, T.A.; Arakawa, E.T.; Beekman, D.W. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From 10. international radiocarbon conference; Bern, Switzerland (19 Aug 1979).

The ability to directly detect a daughter atom, using resonance ionization spectroscopy, in delayed time coincidence with the decay of a parent species promises to drastically reduce the background in low-level counting experiments. Resonance ionization can also be used as an ion source for a mass spectrometer system that is capable of discriminating between isobars.

57240 (CONF-7905111—1) **Fast numerical calculations of ion-atom collisions.** Reading, J.F.; Ford, A.L.; Becker, R.L. (Texas A and M Univ., College Station (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

From Workshop on inner shell processes; Linz, Austria (14 May 1979).

When an ion impinges on an atom, the cross sections for electronic transitions can be described in the independent electron model by functions of single electron amplitudes. A single centered expansion of the time-dependent wave function of an electron about the heavier nucleus, with charge Z/sub N/, is shown to be moderately successful in explaining the dependence of K-shell hole production on the charge, Z/sub p/, of the projectile. However, capture of electrons by the projectile is important for a complete understanding and can be incorporated, in principle, in the single-center approach by evaluation of a transition matrix element involving a final state on the projectile. This is not an easy theoretical problem even in an asymmetric (Z/sub p/ much less than Z/sub N/) collision, because long times are involved which aggravate the inadequacies of a coupled-state calculation where the continuum is replaced by a discrete set of pseudostates. Nevertheless a method was devised which allows convergence in the truncated expansion of Hilbert states. Comparisons are made to experiment. Future developments are discussed.

57241 (COO—2897-3) **Excitation and ionization of highly charged ions by electron impact. Progress report, January 1, 1978-July 31, 1979.** Sampson, D.H. (Pennsylvania State Univ., University Park (USA)). Jul 1979. Contract EY-76-S-02-2897. 19p. Dep. NTIS, PC A02/MF A01.

Reduced ionization cross sections Q/sub R//sup H/(nl,u) were obtained for the nl = 3p and 3d sublevels, as well as for more energy points for the lower sublevels considered in our earlier work. Thus, results are now available for the eight impact electron energies in threshold units u = 1.125, 1.25, 1.5, 2.25, 3.0, 4.0, 5.0, and 6.0 for each of the sublevels 1s, 2s, 2p, 3s, 3p, and 3d. From these results for Q/sub R//sup H/(nl,u) one can readily obtain the cross section for ionization from any of these sublevels in any highly charged complex ion using the simple procedures given in our earlier work. The theory and computer programs developed in our previous work on excitation were used to calculate intermediate coupling collision strengths for all fine structure transitions from the 2P levels to the nP and nD levels with $3 \leqq n \leqq 5$ in He-like ions. Similar calculations have also been made for inner shell excitation of Li-like ions with nuclear charge number Z in the range $10 \leqq Z \leqq 74$. The theory and programs were also extended to treat $\Delta n = 0$ transitions and were used to obtain intermediate coupling collision strengths for all $\Delta n = 0$ fine structure transitions with $n = 2$ in 10 He-like ions with Z in the range $6 \leqq Z \leqq 74$ and 10 Be-like ions with Z in the range $14 \leqq Z \leqq 74$. For excitation the results appear to be accurate to within ~ 30% for $3N \leqq Z \leqq 74$, where N is the number of bound electrons per ion, and more accurate for most of this range. For ionization the results appear to be accurate down to $Z/N \cong 2$. 21 references.

57242 (INIS-mf—4754(No.1), pp 47-48) **Cross sections for charge-changing collisions of 20- to 120-keV oxygen ions and atoms in hydrogen.** Graham, W.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1977.

In International bulletin on atomic and molecular data for fusion. No.1.

57243 (INIS-mf—4754(No.2), pp 46-47) **Charge exchange cross section results for keV-energy multiply charged ions.** Bayfield, J.E. (Pittsburgh Univ., PA (USA)). Oct 1977.

In International bulletin on atomic and molecular data for fusion. No.2.

57244 (INIS-mf—4754(No.2), pp 45) **Electron capture and impact ionization for iron ions colliding with molecular hydrogen.** Berkner, K.H.; Graham, W.G.; Pyle, R.V.; Schlachter, A.S.; Stearns, J.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977.

In International bulletin on atomic and molecular data for fusion. No.2.

57245 (INIS-mf—4754(No.2)) **International bulletin on atomic and molecular data for fusion. No.2.** Beaty, E.C.; Katsonis, K. (eds.). (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Oct 1977. 47p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This bulletin deals with atomic and molecular data for fusion (spectroscopic data, atomic and molecular collisions, surface effects, ...). Particular emphasis is given to data applicable to Tokamak devices. A bibliography for the most recent data presented in the document is provided. A description of work in progress and "Data Requests" in the fusion field are also mentioned. Numerical data on light ion sputtering yields of first wall materials, electron capture and impact ionization for iron ions colliding with molecular hydrogen and charge exchange between multicharged ions and helium, argon, and, atomic or molecular hydrogen are given.

57246 (INIS-mf—4754(No.3)) **International bulletin on atomic and molecular data for fusion. No.3.** Beaty, E.C.; Katsonis, K. (eds.). (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Jan 1978. 42p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This bulletin deals with atomic and molecular data for fusion (spectroscopic data, atomic and molecular collisions, surface effects, ...). Particular emphasis is given to data applicable to Tokamak devices. A bibliography for the most recent data presented in the document is provided. A description of work in progress and "Data Requests" in the fusion field are also mentioned. Numerical data on light-ion sputtering yields of first-wall materials are given.

57247 (INIS-mf—4754(No.4)) **International bulletin on atomic and molecular data for fusion. No.4.** Beaty, E.C.; Katsonis, K. (eds.)

(International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Apr 1978. 46p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This bulletin deals with atomic and molecular data for fusion (spectroscopic data, atomic and molecular collisions, surface effects, ...). Particular emphasis is given to data applicable to Tokamak devices. A bibliography for the most recent data presented in the document is provided. A description of work in progress and "Data Requests" in the fusion field are also mentioned. Data on theoretical studies of the transition probabilities for the $2s^22p^2$-$2s2p^3$-$2p^4$ levels of the Ca XV and Fe XXI ions are presented.

57248 (INIS-mf—4754(No.5), pp 47) **Electron capture and loss cross sections for Ne^+ and Ne^{2+} in He and Ne (experimental).** Nakai, Y.; Ozawa, K.; Kase, M.; Shirai, T.; Kikuchi, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Jul 1978.

In International bulletin on atomic and molecular data for fusion. No.5.

57249 (INIS-mf—4754(No.5)) **International bulletin on atomic and molecular data for fusion. No.5.** Beaty, E.C.; Katsonis, K. (eds.). (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Jul 1978. 48p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This bulletin deals with atomic and molecular data for fusion (spectroscopic data, atomic and molecular collisions, surface effects, ...). Particular emphasis is given to data applicable to Tokamak devices. A bibliography for the most recent data presented in the document is provided. A description of work in progress and "Data Requests" in the fusion field are also mentioned. Experimental cross sections on electron capture for Ne^+ and Ne^{2+} in He and Ne are presented.

57250 (INIS-mf—4754(No.6)) **International bulletin on atomic and molecular data for fusion. No.6.** Katsonis, K.; Smith, F.J. (eds.). (International Atomic Energy Agency, Vienna (Austria). Nuclear Data Section). Oct 1978. 63p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This bulletin deals with atomic and molecular data for fusion (spectroscopic data, atomic and molecular collisions, surface effects, ...). Particular emphasis is given to data applicable to Tokamak devices. A bibliography for the most recent data presented in the document is provided. A description of work in progress and "Data Requests" in the fusion field are also mentioned. Cross-sections for the electron impact excitation of 2sub(p1/2) and 2sub(p3/2) states of the lithium-line ions C^{3+}, F^{23+}, Mo^{39+} and W^{71+} calculated in the relativistic Coulomb-Born approximation are presented.

57251 (LBL—9265) **Ellipsometry of sulfate films on lead.** Muller, R.H.; Peters, R.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 4p. (CONF-791017—6). Dep. NTIS, PC A02/MF A01.

From 7. international conference on chemical vapor deposition; Los Angeles, CA, USA (14 Oct 1979).

Cross sections for electron capture by D^0 and electron loss from D^- in collision with Cs vapor, as well as the D^- equilibrium yield in Cs, Rb, Na vapors. Results are in the range 0.3 to 10 keV. The equilibrium yield for deuterium after passage through thick targets of cesium, rubidium, sodium, magnesium, or strontium vapor and the charge transfer cross sections for $D^0 \rightarrow D^-$ and for $D^- \rightarrow D^0$ in cesium vapor are shown. 5 references. (JFP)

57252 (ORNL—5485, pp 164-172) **Theoretical chemistry.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Topics covered include: variational method for reaction cross sections; atomic physics of channeled ions; the structure of molecular fluids; and theoretical chemical kinetics of unimolecular processes. (GHT)

57253 (ORNL/TM—7020) **Electron impact ionization of multicharged ions.** Crandall, D.H.; Phaneuf, R.A.; Gregory, D.C. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

This report presents original experimental data in tabular and graphical form for electron impact ionization cross sections of the ions B^{3+}, C^{3+}, C^{4+}, N^{3+}, N^{4+}, N^{5+}, O^{3+}, O^{4+}, O^{5+}, and Ar^{4+} for energies between the ionization thresholds and 1500 eV, with absolute accuracy varying between +-6% and +-17%. At present there are no other measurements of comparable accuracy for ions of initial charge greater than 2+. Calculated cross sections from the Lotz formula and scaled-Coulomb-Born prescription are compared with the data. Ionization rate coefficients for plasmas with Maxwellian electron energy distribution were computed from the measured cross sections for each ion species. These rates are compared with available theoretical and measured plasma ionization rates. 23 references.

57254 **Vibrational relaxation of UF_6: Ultrasonic measurements in mixtures with Ar and N_2 .** Cravens, D.; Shields, F.D.; Bass, H.E.; Breshears, W.D. (Department of Physics and Astronomy, The University of Mississippi, University, Mississippi 38677). *J. Chem. Phys.;* **71**: No. 7, 2797-2802(1 Oct 1979).

Ultrasonic attenuation has been measured in neat UF_6 and in mixtures of 5% and 10% UF_6 in Ar and N_2 at 273 and 323 K. In all cases a single relaxation process was observed and attributed to relaxation of the total UF_6 vibrational energy. Isothermal relaxation times were in the range (4—17) x 10^{-9} atm s. The vibrational relaxation rate inferred for UF_6—N_2 collisions shows a slight negative temperature dependence, while the rates inferred for UF_6—UF_6 and UF_6—Ar collisions are virtually independent of temperature over the range of these experiments. In this range, Ar and N_2 are slightly less efficient collision partners (by factors of ~1.5—3.0) than UF_6 itself.

57255 **Spin—orbit coupling and inelastic transitions in collisions of $O(^1D)$ with Ar, Kr, and Xe.** Cohen, J.S.; Wadt, W.R.; Hay, P.J. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 7, 2955-2965(1 Oct 1979).

Inelastic collisions of $O(^1D)$ with Ar, Kr, and Xe have been treated in the multistate Landau—Zener and the close-coupling approximations. The coupling mechanism is spin—orbit mixing. The dependence of the spin—orbit matrix elements on internuclear distance R is calculated using accurate configuration—interaction wave functions and an effective operator composed of one-electron, one-center terms. The R dependence is found to be very significant. Cross sections for transitions to the individual triplet fine-structure levels, as well as the total inelastic (quenching) cross section, are presented as a function of collision energy. The transitions occur primarily at curve crossings and the quenching rate constants were found to be significantly reduced by centrifugal barriers outside the crossing points. The calculated quenching rate constants at 300 K are (5.4 +- 3.5) x 10^{-13}, (6.0 +- 0.7) x 10^{-12}, and (3.0 +- 0.2) x 10^{-11} cm^3 $molecule^{-1}$ s^{-1} for Ar, Kr, and Xe, respectively.

57256 **Electron attachment to perfluorocarbon compounds. III. Fragmentation of aliphatic perfluorocarbons of interest to gaseous dielectrics.** Sauers, I.; Christophorou, L.G.; Carter, J.G. (Atomic, Molecular, and High Voltage Physics Groups, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **71**: No. 7, 3016-3024(1 Oct 1979).

Resonance nondissociative and dissociative attachment of slow electrons (0—12 eV) to the perfluorocompounds 2-C_4F_6, c-C_4F_6, 1,3-C_4F_6, c-C_4F_8, and 2-C_4F_8 have been studied using a time-of-flight mass spectrometer. All five compounds capture thermal energy electrons and form long-lived parent negative ions with autodetachment lifetimes, tau/sub a/, equal to 6, 7, 9, 6, and 10 x 10^{-6} sec for c-$C_4F_6^{-*}$, 1,3-$C_4F_6^{-*}$, 2-$C_4F_6^{-*}$, c-$C_4F_8^{-*}$, and 2-$C_4F_8^{-*}$, respectively. Except for 1,3-C_4F_6, the yield for the parent negative ions of these perfluorocarbons was more than a factor of 10 larger than that of the fragment ions. The following fragment negative ions were detected: 2-C_4F_6: F^-, CF_3^-, $C_3F_3^-$; c-C_4F_6: F^-, $C_3F_3^-$, $C_4F_5^-$; 1,3-C_4F_6: F^-, CF_3^-, $C_3F_3^-$, $C_4F_5^-$; c-C_4F_8: F^-, CF_3^-, $C_2F_3^-$, $C_3F_5^-$; and 2-C_4F_8: F^-, CF_3^-, $C_2F_3^-$, $C_3F_3^-$, $C_3F_5^-$*, $C_4F_6^{-*}$, $C_4F_7^{-*}$, (where the asterisk indicates that these fragment ions were found to be long-lived metastables with tau/sub a/ values equal to 70, 17, and 7 x 10^{-6} sec, respectively). Groups of negative ion resonance peaks were found in the 0—2 eV and 4—6 eV electron impact energy range. Fragmentation patterns indicate that multiple decomposition proceeds via common negative ion states of C_4F/sub x/$^{-*}$ (x = 6 or 8). Fragment ions resulting from multiple bond cleavage and molecular rearrangement in the C_4F/sub x/$^{-*}$ systems were observed as well as ions resulting from direct cleavage. From the appearance onsets of some of the fragment ions we determined ΔH/sub f/($C_3F_3^-$) = -4.4 eV, ΔH/sub f/(2-C_4F_6) = -9.8 eV, E.A. (C_2F_3) > or = 1.6 eV, E.A. (C_3F_5) ~3.0 eV and other thermochemical data. The relevance of this work to the decomposition of dielectric gases is discussed.

57257 **Cluster dynamics: A classical trajectory study of A + A/sub n/arrow-right-leftA*/sub n/+1.** Brady, J.W.; Doll, J.D.; Thompson, D.L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **71**: No. 6, 2467-2472(15 Sep 1979).

The dynamics of the collision of an atom A with a small cluster of atoms, A/sub n/, leading to the formation of a quasibound A*/sub n/+1 complex, which subsequently decays, has been studied using classical trajectories. Pairwise Lennard-Jones potentials (with parameters appropriate for argon) were used to describe the identical point masses (Ar). The results illustrate the feasibility of direct calculations of microscopic rates for nucleation processes. The dissociation of collisionally formed A*/sub n/+1 (n=3,4, and 5) occurs by first-order exponential decay. Furthermore the energy dependence of the dissociation rate constants appears to be well described by the RRK functional form.

57258 Ground-state potential curves for Al_2 and $Al_2/ts^{0+}/$ in the repulsive region. Sabelli, N.H.; Benedek, R.; Gilbert, T.L. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **20**: No. 3, 677-688(Sep 1979).

Self-consistent-field (SCF) calculations have been performed for the short-range interaction between two aluminum atoms. The ground-state potential curve ($^3\Sigma^-$/sub g/→$^5\Sigma^-$/sub u/→$^3\Sigma^+$/sub u/→$^1\Sigma^+$/sub g/→^{3}Pi/sub g/) is presented for internuclear separations between R/sub e/ and 0.1 a.u. (repulsive energies up to ~10^3 a.u.). Basis sets consist of scaled even-tempered Slater orbitals of double-zeta quality, augmented by diffuse functions, with the addition of united or semiunited atom-basis sets centered on the bond. The SCF potentials are compared with Thomas-Fermi theory and with the electron-gas calculations of Wilson, Haggmark, and Biersack. A kink in the SCF screening function is found near R=2 a.u. This feature is believed related to changes in the ground-state configuration that occur in this region. Additional calculations (SCF and linear combination of atomic orbitals were performed on $Al_2/ts^{0+}/$ to determine individually the core overlap and the valence-electron contributions to the interatomic potential. The core-overlap interaction is compared with Gordon-Kim electron-gas calculations. Schematic calculations were also performed on the Al-Al^{3+} system to estimate the interaction between an atom and an energetic ion.

57259 Ab initio adiabatic polarization potentials for low-energy electron-molecule and positron-molecule collisions: The e-N_2 and e-CO_2 systems. Morrison, M.A.; Hay, P.J. (Department of Physics and Astronomy, University of Oklahoma, Norman, Oklahoma 73019). *Phys. Rev., A;* **20**: No. 3, 740-748(Sep 1979).

Most theoretical calculations of cross sections for low-energy electron- and positron-molecule collisions include the important induced-polarization effects in the interaction potential by means of a semiempirical adiabatic approximation based on the known asymptotic form of the potential. In order to examine the validity of the assumptions implicit in this procedure, ab initio adiabatic polarization potentials have been calculated at the self-consistent-field level of accuracy for the e-N_2 and e-CO_2 systems. The resulting potentials deviate from the asymptotic form for intermediate electron positions outside the molecular charge cloud. In addition, the angular dependence of the potentials differs from that assumed in the semiempirical form.

57260 Production of highly charged low-velocity recoil ions by heavy-ion bombardment of rare-gas targets. Cocke, C.L. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark). *Phys. Rev., A;* **20**: No. 3, 749-758(Sep 1979).

The author has measured charge-state (q) spectra of recoil ions generated in single collisions of 25—45-MeV chlorine ions with targets of helium, neon, and argon. A high-efficiency time-of-flight spectrometer was used to identify the charge-to-mass ratio of the slowly moving recoils. Recoil q up to +8 (neon) and +11 (argon) were observed. Cross sections for recoil production were measured as a function of projectile energy and incident charge state. The energy dependence of the cross sections is quite weak, while the recoil-q dependences show clear shell effects in argon. For the lower-q recoils, the cross sections are reasonably well described by the model of Olson, which treats the target electrons as moving independently. For higher q, a model based on energy deposition by the projectile with the target electrons, followed by statistically weighted electron emission, gives a better description of the data.

57261 Role of excited electronic states in the interactions of fast (MeV) molecular ions with solids and gases. Kanter, E.P.; Cooney, P.J.; Gemmell, D.S.; Groeneveld, K.; Pietsch, W.J.; Ratkowski, A.J.; Vager, Z.; Zabransky, B.J. (Physics Division, Argonne National Laboratory, Argonne, Illincis 60439). *Phys. Rev., A;* **20**: No. 3, 834-854(Sep 1979).

The authors report measurements of the joint distributions in energy and angle for fragments arising from the dissociation of 1.2-MeV H_2^+ and 3.0-MeV HeH^+ in thin carbon foils and in a variety of gases at several pressures. From the foil measurements the distribution of initial internuclear separations in the incident projectiles is derived. These distributions are then used in conjunction with the results for gas targets to determine the role of excited electronic states of the projectile in collisionally induced dissociation. Finally, it is shown how these states also play a vital role in some other phenomena that occur in the interactions of fast molecular ions with foils.

57262 Photoionization of the outer shells of neon, argon, krypton, and xenon using the relativistic random-phase approximation. Johnson, W.R.; Cheng, K.T. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). *Phys. Rev., A;* **20**: No. 3, 978-988(Sep 1979).

Multichannel photoionization calculations using the relativistic random-phase approximation for the outer shells in the rare gases, neon, argon, krypton, and xenon, are presented. Total cross sections and partial cross sections for ns subshells are determined and compared with experiment and with alternative calculations at low energies. Branching ratios of ^{2}P/sub 3/2/:^{2}P/sub 1/2/ cross sections which are sensitive to relativistic and correlation effects are presented and compared with experiment. Angular distribution asymmetry parameters β determined for each subshell are found and compared with experiment; the differences between β values for ^{2}P/sub 1/2/ and ^{2}P/sub 3/2/ subshells in krypton and xenon emphasize the importance of relativistic effects in outer subshells of heavy elements. Values of β are given for outermost s electrons which show large relativistic effects near the "Cooper minima" of the corresponding partial cross sections. Eigenphases from the multichannel analysis are presented for argon to illustrate mathematical features of the present calculation.

57263 Line shapes for laser-induced collisions. Payne, M.G.; Anderson, V.E.; Turner, J.E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., A;* **20**: No. 3, 1032-1044(Sep 1979).

The two-state Yakovlenko is shown to lead to cross sections with a universal behavior in terms of the variables z =vertical-barC$_3$vertical-barE$_0$v/sup -3/5/ vertical-barC$_6$vertical-bar/sup -2/5/ and d=δvertical-barC$_6$vertical-bar/sup 1/5/v/sup -6/5/ sgn(C$_6$). The dimensionless frequency-detuning variable is d proportional (detuning of the laser from the large-R resonance) (time of collision at the Weisskopf radius). The dimensionless variable z is independent of laser frequency and measures the power dependence of the cross section. It is proportional to ∫/sup t//sub -infinity/ C_3E_0 dt/R (t)^3 evaluated at an impact parameter given by the b/sub v/= (C$_6$/v)/sup 1/5/ proportional to Weisskopf radius=impact parameter where the phase shift due to the Van der Waals potential becomes π. Above, C_3E_0/R^3 is the coupling parameter at intranuclear separation R and E_0 is the laser field amplitude. The cross section is of the form σ = (vertical-barC$_6$vertical-bar /v)/sup 2/5/,z), where H(d,z) is tabulated in detail. For large laser fields (i.e., z>2), the line shape for collisions at a particular relative velocity v, laser field amplitude E_0, and detuning (from the large-R resonance frequency), σ becomes symmetric about δ=0 with the width decreasing with increasing laser power. The physical reason for the symmetric H(d,z) at large z is shown to be the decreased importance of curve-crossing effects for large positive d corresponding to the onset of adiabatic behavior and the increased importance of contributions to σ from such large impact parameters that the Van der Waals shifts can be neglected. Correspondingly, at large z the linewidth is due entirely to time-of-collision effects. When z> or =2, both the long-range version of the atom-atom interaction and the assumption of straight-line orbits are excellent because of the dominant contribution to δ from impact parameters >15 A.

57264 Measured cross sections for ionisation of C^{3+}, N^{4+} and O^{5+} ions with contribution due to excitation-autoionisation. Crandall, D.H.; Phaneuf, R.A.; Hasselquist, B.E. (Oak Ridge National Lab., TN (USA)); Gregory, D.C. *J. Phys., B (London);* **12**: No. 7, L249-L256(14 Apr 1979).

Measured cross sections for electron impact ionisation of Li-like ions of C^{3+}, N^{4+} and O^{5+} are reported for energies from threshold to 1500 eV. For electron energies from near threshold through the first peak in the cross sections, the measured values are in reasonable agreement with Coulomb-Born calculations. However, in each case an abrupt increase in the measured ionisation cross section is observed at the electron energy associated with excitation of an inner-shell electron, a process which has not been included in the theories. The $1s^2$ 2s → excitation followed by autoionisation is shown to give an abrupt and significant contribution to the total ionisation cross section. Further, the relative contribution of the excitation-autoionisation process increases with increasing ionic (or nuclear) charge for the three cases tested along the Li isoelectronic sequence.

57265 (LA-tr—79-38) **Theory of collisions between electrons and hydrogen atoms.** Drukarev, G.F. Translated from *Zh. Eksp. Teor. Fiz.;* **25**: No. 2 129-138(1953). 16p. Dep. NTIS, PC A02/MF A01.

It is shown that the method for the calculation of exchange effects in the collision of electrons with atoms which was developed previously is based on an erroneous hypothesis. The collision of an electron with a hydrogen atom is described with the aid of a wave function for a two-electron system, the function having appropriate symmetry in an implicit form. A finite system of integro-differential equations is deduced for functions which describe the state of an incident electron. 5 references.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 57238, 57252, 57376

57266 (SAND—79-1240C) **Auger lineshape analysis of molecules and solids.** Jennison, D.R. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 20p. (CONF-791013—4). Dep. NTIS, PC A02/MF A01.

From 26. national vacuum symposium; New York, NY, USA (2 Oct 1979).

Considerable recent theoretical work has shown that core-valence-valence Auger lineshape analysis may often be successfully made in terms of the molecular orbital structure of the molecule or the band structure of the solid. This approach assumes a priori that the final state hole motion is uncorrelated. Limitations to this approach include the highly correlated final states observed in ionic and narrow band solids (as Cu). Complications to this approach include the initial state valence screening of the core hole which affects the Auger decay probabilities. However, much useful information about the local density of states (local chemical environment) may be extracted in covalent and metallic materials. Examples from molecular (CH_4, C_2H_4, C_2H_6, C_3H_8, and H_2O) and solid state (Cu and Be) spectra are presented and the state of understanding of lineshape analysis is summarized. 30 references.

57267 Semiclassical calculation of bound states in multidimensional systems with Fermi resonance. Noid, D.W.; Koszykowski, M.L.; Marcus, R.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **71**: No. 7, 2864-2873(1 Oct 1979).

A method is devised to calculate eigenvalues semiclassically for an anharmonic system whose two unperturbed modes are 2:1 degenerate. For some special states the periodic energy exchange between unperturbed modes is found to be very large. The quantum mechanical wave functions are examined and a correlation with the classical trajectories is described, both for quasiperiodic and the stochastic cases. A method used in the literature for calculating the stochastic limit is tested and found to break down when the present anharmonic system is separable.

57268 Generalization of the Faulkner—Richardson method for calculating polyatomic Franck—Condon factors. Kulander, K.C. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **71**: No. 6, 2736-2737(15 Sep 1979).

Faulkner and Richardson's approach for evaluating multidimensional Franck-condon and Herzberg-Teller integrals is used to calculate Franck-condon factors for polyatomic molecules and generalized to include transitions from excited states to excited states. (AIP)

FLUID PHYSICS

57269 (ORNL/CSD—44) **Bibliography on moving boundary problems with key word index.** Wilson, D.G.; Solomon, A.D.; Trent, J.S. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 195p. Dep. NTIS, PC A09/MF A01.

This bibliography concentrates mainly on time-dependent moving-boundary problems of heat and mass transfer. The bibliography is in two parts, a list of the references ordered by last name of the first author and a key word index to the titles. Few references from before 1965 are included. (RWR)

GENERAL FLUID DYNAMICS

57270 (KAPL—4123) **Boundary conditions for flow computation with nonorthogonal curvilinear coordinates.** Muro, P.F.; Wachspress, E.L. (Knolls Atomic Power Lab., Schenectady, NY (USA)). Jul 1979. Contract EY-76-C-12-0052. 14p. (CONF-791205--4). Dep. NTIS, PC A02/MF A01.

From ASME winter annual meeting; New York, NY, USA (2 Dec 1979).

Discretization of the Navier-Stokes equations and their numerical solution over a region partitioned into four-sided isoparametric elements was discussed in an earlier work. The manner in which boundary conditions are handled at walls and at channel inlet and outlet was, however, not discussed. The incorporation of boundary conditions in the equations is examined here.

57271 Structure of relativistic shock waves in simple gases. Chapline, G.F.; Weaver, T.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **22**: No. 10, 1884-1889(Oct 1979).

Numerical solutions of the exact relativistic nonlinear Boltzmann equation have been obtained which describe the structure of relativistic shock transitions in dilute one-component simple gases. When the speed of the shock wave is near the speed of light, the calculated velocity profiles, as viewed in the rest frame of the shock wave, are similar to the velocity profiles of weak nonrelativistic shock waves. Starting from this observation an analytic theory for the velocity profile is derived which is accurate for all relativistic energies and may be used to study relativistic shock waves in nonideal fluids where the Boltzmann equation is not valid.

57272 Finite elements in fluids. Volume 2. Mathematical foundations, aerodynamics and lubrication. Gallagher, R.H.; Oden, J.T.; Taylor, C.; Zienkiewicz, O.C. (eds.). New York, NY; Wiley and Sons (1975). 299p. (CONF-7401145—P2). The Publisher, 605 3rd Ave., New York, NY.

From International symposium on finite elements methods in flow problems; Swansea, UK (7 Jan 1974).

An abstract was prepared for the paper on hydromagnetic instabilities in plasma physics. (MOW)

PROPERTIES AND STRUCTURE OF FLUIDS

57273 Critical phenomena in fluid films: Scaling crossover and law of corresponding states. Scheibner, B.A.; Meadows, M.R.; Mockler, R.C.; O'Sullivan, W.J. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev. Lett.;* **43**: No. 8, 590-592(20 Aug 1979).

Thirty-two coexistence curves were measured for films of a critical mixture of 2,6-lutidine + water for film thicknesses 0.46 μm $<$ or $=$ L $<$ or $\approx$ 14 μm. For a sample of twenty-eight films with L $<$ 6 μm, the coexistence curves show a crossover from three-dimensional scaling characterized by $\beta = 0.332 \pm 0.003$ to two-dimensional Ising-model scaling with $\beta = 0.126 \pm 0.005$. The scaling requirement that a law of corresponding states exists for such films has been confirmed.

57274 Critical phenomena in fluid films: Critical-temperature—shift, crossover-temperature, and coexistence-curve—amplitude exponents, and a fluid-boundary interaction. Meadows, M.R.; Scheibner, B.A.; Mockler, R.C.; O'Sullivan, W.J. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev. Lett.;* **43**: No. 8, 592-595(20 Aug 1979).

Refractive-index coexistence curves for films of the binary fluid mixture 2,6-lutidine + water are analyzed. The critical-temperature—shift exponent and the crossover-temperature exponent agree well with scaling-theory predictions. The two-dimensional coexistence-curve amplitudes are largely consistent with the scaling prediction. The predicted behavior is superimposed on systematically displaced coexistence curves. We argue that the displacement arises from interaction between the fluid and the plane mirrors which confine it.

MAGNETOHYDRODYNAMICS

57275 (INIS-mf—4820, pp 82-96) **Superconducting magnets for an experimental mhd generator.** Volkov, Yu.M.; Keilin, V.E.; Klimenko, E.Yu. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The results of calculation and testing of a superconducting magnetic systems (SMS) with a mangetic field of 5 T for a research MHD generator with a channel volume of 110 x 300 x 500 mm are presented. The system consists of two identical solenoids divided in the axial direction. Each of the solenoids has nine two-layer coils mounted on a power framework. All the coils are connected in series . A circuit of two-stage cooling with the aid of nitrogen in the first stage and liquid helium in the second one is used. The distributions of the axial and radial components of the volume ponderomotor force density in SMS were calculated. The results of SMS testing confirmed the possibility of developing large magnetic systems with an induction of 5 T in the working zone for thermonuclear devices.

HIGH ENERGY PHYSICS

57276 (COO—3230-2) **Research in elementary particle physics. Technical progress report, May 1, 1978-May 29, 1979.** Kirsch, L.E.; Schnitzer, H.J. (Brandeis Univ., Waltham, MA (USA). Dept. of Physics). 1979. Contract EY-76-S-02-3230. 15p. Dep. NTIS, PC A02/MF A01.

Theoretical and experimental high energy physics is summarized. A list of publications is included. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

REFER ALSO TO CITATION(S) 57281

57277 (COO—1195-434) **Annual progress report.** Wattenberg, A.; Simmons, R.O. (Illinois Univ., Urbana (USA). Dept. of Physics). Mar 1979. Contract EY-76-C-02-1195. 29p. Dep. NTIS, PC A03/MF A01.

Experimental high energy research is summarized. A list of publications is included. (JFP)

ELECTROMAGNETIC INTERACTIONS

57278 Measurement of the radiative width of the eta' in two-photon interaction at SPEAR. Abrams, G.S.; Alam, M.S.; Blocker, C.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 7, 477-480(13 Aug 1979).

Events of the type $e^+e^- \rightarrow e^+e^-$ eta' (958) have been observed with the Mark II detector at SPEAR by detecting the decay mode eta' $\rightarrow$ rho$^0\gamma$. From the observed cross section and known branching fractions of the eta' is Γ/sub gammagamma/ = 5.9 +- 1.6 +- 1.2 keV and the total width is Γ = 300 +- 90 +- 60 keV (statistical and systematic errors).

57279 Evidence for the high-energy photoproduction of charmed mesons. Atiya, M.S.; Holmes, S.D.; Knapp, B.C.; Lee, W.; Wisniewski, W.J.; Avery, P.; Butler, J.; Gladding, G.; O'Halloran, T.; Russell, J.J.; Wattenberg, A.; Wiss, J.; Binkley, M.; Cumalat, J.P.; Gaines, I.; Gormley, M.; Loveless, R.L.; Peoples, J. (Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **43**: No. 6, 414-416(6 Aug 1979).

We report on a search for the photoproduction of D^0 (D-bar^0) mesons in events which have zero total visible strangeness. We observe an enhancement of 94 +- 19 events in the $K^{+-}\pi^{-+}$ decay mode, corresponding to a cross section of $\sim$ 720 nb assuming a branching ratio of 0.018.

WEAK INTERACTIONS

57280 Observation of Cabibbo-suppressed decay $D^0 \rightarrow \pi^-\pi^+$ and $D^0 \rightarrow K^-K^+$. Abrams, G.S.; Alam, M.S.; Blocker, C.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 7, 481-483(13 Aug 1979).

The D^0 Cabibbo-suppressed decay modes $\pi^-\pi^+$ and K^-K^+ have been observed and the following ratios of D^0 partial decay widths have been measured: $\Gamma(D^0 \rightarrow \pi^-\pi^+)/\Gamma(D^0 \rightarrow K^-\pi^+)$ = 0.033 +- 0.015 and $\Gamma(D^0 \rightarrow K^-K^+)/\Gamma(D^0 \rightarrow K^-\pi^+)$ = 0.113 +- 0.030.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 57288

57281 (BNL—26515) **New directions in elementary particle physics: p anti p from very low to very high energies.** Jacob, M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 60p. Dep. NTIS, PC A04/MF A01.

The review covers low energy anti pp physics including annihilation processes, the spectroscopy of baryonium states, quasinuclear states and their relation to baryonium, the spectroscopy of protonium, and access to the whole charmonium family. High energy anti pp physics is reviewed covering total cross section rise, the common shape of cross sections, real part of forward amplitude, particle production, quantum number excitation, high transverse momentum, and high mass lepton pair. Also reviewed are the search for the weak bosons, hadron physics at collider energies, and the anti pp collider program. 47 references. (JFP)

57282 (BNL—26604) **Exotic atoms and hypernuclei.** Dover, C.B. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 6p. (CONF-790847—6). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

Recent progress is reviewed in hypernuclear and exotic atom physics. A discussion of quasiatomic and very energetic γ rays from the anti pp atom, and their possible relevance to the multiquark baryonium states is included. Also summarized is the most recent results on the study of Λ and Σ hypernuclei, in particular the proposals for the central and spin-orbit components of the single particle potentials and the spin-spin term in the Λ N residual interaction, as revealed by hypernuclear spectra and γ ray transitions. 39 references.

57283 Inclusive production of K/sup asteriskplus-or-minus/(890) and Σ^{+-}(1385) resonances in p-barp interactions at 14.75 GeV/c. Canter, J.; Chang, C.C.; Dao, F.T.; Gelfand, E.; Mann, W.A.; Reinhardt, T.; Schneps, J.; Wald, H.; Wisnieff, R.; Kitagaki, T.; Tanaka, S.; Yuta, H.; Abe, K.; Hasegawa, K.; Yamaguchi, A.; Nozaki, T.; Tamai, K.; Kikuchi, R.; Maruyama, T.; Unno, Y.; Kunori, S.; Oh, B.Y.; Pratap, M.; Smith, G.A.; Whitmore, J.; Lach, J. (Tufts University, Medford, Massachusetts 02155). *Phys. Rev., D;* **20**: No. 5, 1029-1036(1 Sep 1979).

The inclusive and semi-inclusive cross sections for K/sup asteriskplus-or-minus/(890) and Σ^{+-}(1385) resonances are determined in p-barp interactions at 14.75 GeV/c. They account for a large fraction of the K^0/sub S/ and Λ^0 produced. The K/sup asterisk/-resonance production also affects the low-p/sub T//sup ts2/ distribution of inclusive K^0/sub S/. The x distributions of the resonance production are studied in terms of a simple quark-recombination model.

57284 Production and correlations of charged particles with high p/sub t/ in 200-GeV/c π^{+-}p, K$^-$p, and pp collisions. Bromberg, C.; Fox, G.; Gomez, R.; Pine, J.; Stampke, S.; Yung, K.; Erhan, S.; Lorenz, E.; Medinnis, M.; Rohlf, J.; Schlein, P.; Ashford, V.; Haggerty, H.; Juhala, R.; Malamud, E.; Mori, S.; Abrams, R.; Delzenero, R.; Goldberg, H.; Margulies, S.; McLeod, D.; Solomon, J.; Stanek, R.; Dzierba, A.; Kropac, W. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **43**: No. 8, 561-564(20 Aug 1979).

Results are presented on the production of single charged particles with transverse momentum in the range of 0.8—4.5 GeV/c in π^{+-}p, K$^-$p, and pp collisions at 200 GeV/c and on correlations between the trigger particle and particles with opposite azimuthal angle.

57285 Experimental tests of quantum chromodynamics in high-p/sub perpendicular/ jet production in 200-GeV/c hadron-proton collisions. Bromberg, C.; Fox, G.; Gomez, R.; Pine, J.; Rohlf, J.; Stampke, S.; Yung, K.; Erhan, S.; Lorenz, E.; Medinnis, M.; Schlein, P.; Ashford, V.; Haggerty, H.; Juhala, R.; Malamud, E.; Mori, S.; Abrahms, R.; Delzenero, R.; Goldberg, H.; Margulies, S.; McLeod, D.; Solomon, J.; Stanek, R.; Dzierba, A.; Kropac, W. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **43**: No. 8, 565-568(20 Aug 1979).

Data on inclusive jet production in the transverse-momentum (p/sub perpendicular/) range 0—8 GeV/c for 200-GeV/c p, π^-, π^+, K^-, K^+, and p-bar incident on a hydrogen target are presented. The jet cross section is fully corrected for losses and biases, and compared with the predictions of a model based on quantum chromodynamics. Both the absolute cross section and the inclusive charged-particle distributions inside and outside the jet are in qualitative agreement with the model.

57286 Observation of prompt single-muon production by 400-GeV protons. Brown, K.W.; Barish, B.C.; Bartlett, J.F.; Bodek, A.; Shaevitz, M.H.; Siskind, E.J.; Diamant-Berger, A.M.; Dishaw, J.P.; Faessler, M.; Liu, J.K.; Merritt, F.S.; Wojcicki, S.G. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **43**: No. 6, 410-413(6 Aug 1979).

We have observed a prompt single-muon signal in the region 0.8 < p/sub t/ < 2.5 GeV/c produced by the interactions of 400-GeV protons in steel. The prompt 1-μ^+ rate is comparable in magnitude to the prompt 2-μ rate in the same kinematic region. If interpreted as originating from the production and muon decay of charmed particles, the 1-μ signal corresponds to a charm production cross section in the range of 13 to 60 μb/nucleon, depending on production parameters.

57287 Tensor analyzing power in pd backward scattering at GeV energies. Igo, G.; Bleszynski, M.; Carroll, J.B.; Sagle, A.; Morris, C.L.; Klem, R.; Joyce, T.; Makdisi, Y.; Marshak, M.; Mossberg, B.; Peterson, E.A.; Ruddick, K.; Whittaker, J. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024). *Phys. Rev. Lett.;* **43**: No. 6, 425-429(6 Aug 1979).

Measurements are reported of the sperical tensor component t_{20} for 1.0-, 0.8-, and 0.4-GeV equivalent proton bombarding energies for elastic p-d scattering between 155°—175°. They are very close to zero in disagreement with the predictions of nucleon exchange models, including the Kerman-Kisslinger model with N* components in the deuteron wave function. The experiment was performed with a vector- and tensor-polarized deuteron beam scattered from a liquid hydrogen target.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 57282

57268 (COO—3071-242) **High p/sub T/ jet studies at Fermilab.** Selove, W. (Pennsylvania Univ., Philadelphia (USA)). May 1979. Contract EY-76-C-02-3071. 45p. (UPR—70E; CONF-790365—8). Dep. NTIS, PC A03/MF A01.

From 16. rencontre de moriond; Les Arcs, Savoie, France (17 Mar 1979).

Two experiments using calorimeters to select and to analyze high p/sub T/ events are reviewed. Jets were seen clearly, and 2-jet events were found to have all the characteristics expected for parton-parton scattering. Results were obtained for the structure function of the pion, and for parton transverse momentum. The results are compared with results obtained from di-muon production. 72 references.

57289 (LA—7892C, pp 40-52) **Pion proton charge exchange.** Truol, P. (Physik-Institut der Universitaet, Zurich, Switzerland); Zupancic, C. Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

A review is given of the different experimental techniques applied to cross section measurements for $\pi^- p \rightarrow \pi^0 n$ near and above the P_{33} resonances and of some preliminary results of an experiment presently in progress to measure charge-exchange polarization. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

57290 (COO—2271-102) **Theoretical high energy physics. Progress report, May 1, 1978-April 30, 1979.** Lee, T.D. (Columbia Univ., New York (USA). Dept. of Physics). Jun 1979. Contract EY-76-C-02-2271. 21p. Dep. NTIS, PC A02/MF A01.

Theoretical high energy physics is summarized. Publications are indicated. (JFP)

GENERAL

REFER ALSO TO CITATION(S) 57314

57291 (SLAC-PUB—2357) **New Orthodoxy: how can it fail.** Bjorken, J.D. (Stanford Linear Accelerator Center, CA (USA)). Jul 1979. Contract EY-76-C-03-0515. 11p. (CONF-790648—6). Dep. NTIS, PC A02/MF A01.

From Neutrino 1979 conference; Bergen, Norway (18 Jun 1979).

The new orthodoxy of high energy physics is considered, namely, the grand unified SU(5) symmetry. Present quiet-time attitudes of researchers, variations of the main theories, and the composite degrees of freedom are discussed. The credibility problem created by the gauge hierarchy problems in the SU(5) scheme is noted. 53 references. (JFP)

57292 **Hadronic corrections to the annihilation rate of heavy vector mesons to lepton pairs.** Poggio, E.C.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **20**: No. 5, 1175-1186(1 Sep 1979).

Hadronic corrections to the annihilation rate of heavy vector mesons to lepton pairs are considered to leading nontrivial order in gluon exchange and in the quark-confining potential. It is shown that, to an excellent approximation, the rate is $\Gamma(V \rightarrow l^+l^-) \simeq (16\pi\alpha^2 e/\text{sub } Q/\ ^2/M^2)$ vertical-barphi$_0$(r = 1/m) vertical-bar^2, where M ≃ 2m is the vector-meson mass and phi$_0$(r) is the solution of the zeroth-order nonrelativistic quark-antiquark bound-state problem. This has the effect of reducing the Van Royen—Weisskopf prediction for the rate.

57293 **Minimal anomaly-free electroweak model for several generations.** Davidson, A.; Koca, M.; Wali, K.C. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **20**: No. 5, 1195-1206(1 Sep 1979).

A horizontal U'(1) gauge symmetry is invoked to distinguish several fermion generations which have one and the same Weinberg-Salam (WS) structure. It is assumed that both weak hypercharges associated with the WS U(1) and the new U'(1) factorize, i. e., they are of the form λ/sub i/y and λ'/sub i/y', where the scales λ/sub i/, λ'/sub i/ are the so-called seriality numbers of the ith generation. The motivation for such an assumption comes from the standard WS model. The generation structure is extended to the Higgs system as well, i.e., associated with the ith generation, there is an ith Higgs doublet whose U' (1) hypercharge is λ'/sub i/h, where h is a number. We study as a prototype the simplest but the fundamental two-generation scheme in detail and show how, when the above assumptions are combined with (a) anomaly-free conditions, (b) conservation of lepton numbers, and (c) the emergence of a proper Cabibbo structure, we are led to a unique choice for Y' which can be expressed as Y' = -+[Y/3 + 2(B - L)/3] with the (-+) signs being the seriality numbers for the two generations, respectively. A hierarchy in the vacuum expectation values (VEV's) of the Higgs doublets produces the desired hierarchy in the fermion masses, and correlates the smallness of m/sub e/ with the smallness of m/sub u/, m/sub d/, and θ/sub C/. The gauge boson associated with U'(1) produces of course the undesirable flavor-changing neutral currents and the violation of e-μ universality. However, an additional Higgs singlet with zero Y and with a large VEV suffices to make the mass of Z' heavy enough to suppress the unwanted features to any desirable degree. From the K/sub L/-K/sub S/ mass difference we estimate M (Z') > (1/α) M(Z). We investigate briefly a three-generation scheme. The existence of a third generation suggests the existence of a fourth one as well.

57294 **Confinement and the critical dimensionality of space-time.** Creutz, M. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **43**: No. 8, 553-556(20 Aug 1979).

Using Monte Carlo techniques, we study pure SU(2) gauge fields in four and five space-time dimensions and a compact SO(2) gauge field in four dimensions. Ultraviolet divergences are regulated with Wilson's lattice prescription. Both SU(2) in five dimensions and SO(2) in four dimensions show clear phase transitions between the confining regime at strong coupling and a spin-wave phase at weak coupling. No phase change is seen for the four-dimensional SU(2) theory.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 57302, 57304

57295 (SLAC-PUB—2362) **Quark structure functions of mesons, fragmentation functions, higher-twist effects in QCD, deep inelastic scattering, and the Drell-Yan process.** Berger, E.L. (Stanford Linear Accelerator Center, CA (USA); Argonne National Lab., IL (USA)). Jul 1979. Contract EY-76-C-03-0515. 46p. (CONF-790642—5). Dep. NTIS, PC A03/MF A01.

From International conference on high energy physics; Geneva, Switzerland (27 Jun 1979).

Inclusion of specific effects associated with constituent binding in hadronic wave functions is shown to lead to important nonscaling, nonfactorizing $1/Q^2$ contributions to cross sections for semi-inclusive deep-inelastic scattering, the Drell-Yan process, and other hard scattering reactions. These $1/Q^2$ higher-twist terms are predicted to be dominant in well defined kinematic regions such as large x and/or large z. They provide angular distributions typical of longitudinally polarized virtual photons and W's, including $\sin^2\theta$ terms in meson induced Drell-Yan processes and in $e^+e^- \rightarrow \pi X$, as well as unusual (1-y) terms in deep-inelastic scattering. Calculations are also presented of the quark structure functions of the pion q/sub π/(x,Q^2) and for the quark to pion fragmentation function D/sub π(z,Q^2). Predictions are made for the azimuthal angle dependence of the cross sections for $\pi N \rightarrow \mu$ anti μX and $lN \rightarrow l'\pi X$.

57296 (SLAC-PUB—2366) **Electron-positron annihilation: some remarks on the theory.** Bjorken, J.D. (Stanford Linear Accelerator Center, CA (USA)). Aug 1979. Contract EY-76-C-03-0515. 13p. (CONF-790642—6). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics; Geneva, Switzerland (27 Jun 1979).

Some topics in e^+e^- annihilation are reviewed including high-quality QCD tests, jet production, production of old and new leptons and quarks, gluonium, Higgs-bosons, and unconfined quarks. 56 references.

57297 **Quantum-chromodynamic phenomenology of gluon jets.** Shizuya, K.; Tye, S.H. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **20**: No. 5, 1101-1114(1 Sep 1979).

We investigate in detail, within the framework of perturbative quantum chromodynamics, properties of the gluon jet in comparison with those of the quark jet. The short-distance features of a gluon jet are quite similar to those of a quark jet, apart from the difference in the overall color charges $C_2(G)/C_2(R) = 9/4$. The spread of a gluon jet in the transverse momentum is much bigger than that of a quark jet and the narrowing of a gluon jet with increasing energy is slower than that of a quark jet. We also evaluate the thrust T distribution which has the same features for both types of hadronic jets. The average <1 - T> and higher "thrust moments" < (1 - T)/sup n/> for the gluon-jet case are again approximately $C_2(G)/C_2(R) = 9/4$ times those for the quark-jet case. The usefulness of these thrust moments is emphasized. The implication of the above result on the search for gluon jets is discussed, especially in the hadronic decay of a heavy quarkonium state. We express the gluon-jet production cross section in terms of the Altarelli-Parisi parton functions. We emphasize that the spread of the gluon jet is a very clean place to measure the triple-gluon vertex coupling, since it provides the dominant contribution in the transverse-momentum spread.

57298 **Exclusive processes in quantum chromodynamics: The form factors of baryons at large momentum transfer.** Lepage, G.P.; Brodsky, S.J. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **43**: No. 8, 545-549(20 Aug 1979).

The form factors of baryons at large momentum transfer are computed in quantum chromodynamics (QCD) to leading order in α/sub s/(Q^2) and m^2/Q^2. Asymptotically, we predict Q^{4}G/sub M/ / sup p/(Q^2) → C[α/sub s/(Q^2)]/sup 2+4/3beta/ and G/sub M/ /sup n//G/sub M/ /sup p/ → -2/3, where $\beta = 11 - (2/3)$ n/sub flavor/ and C > 0. Form factors for processes in which the baryon helicity is changed or in which the initial or final baryon has helicity greater than 1 are suppressed by factors of m/Q. We also give QCD

predictions for general exclusive scattering processes at large momentum transfer.

57299 Determining meson radiative widths from Primakoff-effect measurements. Kamal, A.N.; Kane, G.L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 8, 551-553(20 Aug 1979).

We suggest that the measurement of vector-meson radiation decays $V \rightarrow P\gamma$ in the Primakoff-effect experiments on nuclei should be reanalyzed including isovector hadronic exchange. Its inclusion invalidates the assumption, made in data analyses, of A independence of the strength of the strong-production amplitude and could well remove the disagreement between theory and experiment for Γ (rho $\rightarrow \pi\gamma$) and Γ ($K^{*0} \rightarrow K^0\gamma$).

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 57296, 57301, 57305

57300 Diagrammatic analysis of some contributions to the $\Delta I = 1/2$ rule. Wise, M.B.; Witten, E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 5, 1216-1220(1 Sep 1979).

Higher-order gluon corrections to a particular mechanism for the $\Delta I = 1/2$ rule are computed using quantum chromodynamics. It is found that due to gauge invariance these corrections leave the form of the lowest-order result essentially unchanged.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 57296

57301 (COO—1764-358) **Charmed particle lifetimes.** Rosner, J.L. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy). 1979. Contract EY-76-C-02-1764. 20p. Dep. NTIS, PC A02/MF A01.

Conventional estimates are reviewed for charmed particle lifetimes. Free-quark models give values of (a few) x 10^{-13} sec to (a few) x 10^{-12} sec. The shorter of these values also follows from an extrapolation based on D → Ke/sup nu/. Possible differences among the lifetimes and production rates of D^0, D^+, F^+, C_0^+, the heavy lepton tau, and the fifth quark o are discussed. Extreme values of mixing angles in a six-quark model could extend charmed particle lifetimes by a factor of at most three from the above estimates, while shorter lifetimes than those predicted could occur for some species like D^0 or F^+ if their nonleptonic decays were enhanced. The predictions are discussed in the light of some current experimental results, and it is estimated that σ(pp → charm) ≅ 10 μb at 400 GeV/c. 95 references.

57302 (COO—1764-360) **Quantum mechanics with applications to quarkonium.** Quigg, C.; Rosner, J.L. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy; Fermi National Accelerator Lab., Batavia, IL (USA)). Feb 1979. Contract EY-76-C-02-1764. 141p. Dep. NTIS, PC A07/MF A01.

Some methods of nonrelativistic quantum mechanics which are particularly useful for studying the variation of bound-state parameters with constituent mass and excitation energy are reviewed. These techniques rely upon elementary scaling arguments and on the semiclassical (WKB) approximation. They are of general interest, but are applied here to the study of bound systems of a heavy quark and antiquark. Properties of the interquark interaction are extracted from information about masses and leptonic widths of the Psi and T families. It is shown how general methods can be applied to the determination of the electric charge of quarks and to the prediction of properties of new families. 113 references.

57303 (COO—3069-T1) **Deformed shapes of hadrons.** Parmentola, J. (Massachusetts Inst. of Tech., Cambridge (USA)). Jun 1979. Contract EY-76-C-02-3069. 37p. Dep. NTIS, PC A03/MF A01.

The possibility is considered that the shape of the ground state configuration of a system of quarks interacting with a real scalar field is nonspherical. This is explored through application of the variational principle to a simple model field theory of quarks coupled linearly to a real scalar field. Trial functions are, by construction, eigenstates of linear and angular momentum and correspond to quarks confined by an ellipsoidal well of major axis, a, and minor axis, b, with zero depth and height g phi$_0$, where g is the quark-scalar particle coupling constant. The parameters a, b, and phi$_0$ are determined such that their values minimize the total energy of the system. These variations are carried out in the limit when the renormalized scalar particle mass, μ, is taken to infinity and the energy takes on a semi-classical form. Furthermore, in the renormalized limit (i.e., when the renormalization cutoff goes to infinity) it is found that the energy depends on two finite arbitrary constants and that there exists a minimum of the energy for which the eccentricity of the confining well is nonzero. In fact, the spherical configuration is unstable and of higher energy. The model is applied to hadron spectroscopy for the low lying (mass < 2 GeV) nonstrange baryons with j ≦ 3/2. 15 references.

57304 (DOE/ER/01388—757) **What is glue good for, or gluons come out of the closet.** Ellis, S.D. (Washington Univ., Seattle (USA)). Jun 1978. Contract EY-76-C-06-1388. 10p. (RLO—1388-757; CONF-780353—9). Dep. NTIS, PC A02/MF A01.

From 13. high energy hadronic interactions sessions; Les Arcs, France (12 Mar 1978).

The possible role of gluons in hadronic processes as suggested by the quark-parton model and QCD is discussed and evaluated. Attention is focused on heavy (e.g., charmed) hadron production, large p/sub T/ hadronic physics, and massive lepton pair production at large p/sub T/. A discussion of more rigorous tests of QCD and the role of gluons in e^+e^- annihilation is also given. 55 references.

57305 (SLAC-PUB—2363) **Quarks and leptons: the generation puzzle.** Harari, H. (Stanford Linear Accelerator Center, CA (USA)). Jul 1979. Contract EY-76-C-O3-0515. 24p. (CONF-790388—1). Dep. NTIS, PC A02/MF A01.

From The Einstein centennial symposium; Jerusalem, Israel (14 Mar 1979).

Some crucial questions with regards to the physics of the world beyond the standard view of quarks and leptons are investigated. The standard view is set forth, its problems noted, and its possibilities considered, particularly that of the grand unification scheme. Some open questions are listed. 29 references. (JFP)

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 57296, 57301, 57303

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 57295, 57301, 57303

57306 Peculiarities of solutions to the Chew Low equation in the no crossing approximation. Ernst, D.J. (Texas A and M Univ., College Station (USA). Dept. of Physics); Friedenberg, R.A. (Washington Univ., Seattle (USA). Dept. of Physics); Johnson, M.B. (Los Alamos Scientific Lab., NM (USA)). *Z. Phys., A;* **287**: No. 3, 363-367(1978).

We show that the canonical presciption for finding a solution to the static Chew-Low theory of the pion-nucleon interaction breaks down for physically acceptable values of the coupling constant and form factor, if crossing symmetry is dropped. The difficulty is associated with the appearance of a pole (whose behavior is similar to a 'ghost state' pole) in the scattering amplitude in repulsive channels. We show that solutions without this pole can be obtained by including CDD poles in the denominator function, giving rise to a zero in the amplitude or the positive real axis.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 57282, 57358, 57366

57307 (LA—7892C, pp 298-313) **Present and future prospects for kaon physics.** Dover, C.B. (Univ. of Pennsylvania, Philadelphia). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The formation of hypernuclei via the (K^-,π^-) reaction at 0° as well as (K^-,π^-) angular distributions are surveyed with regards to their status and theoretical interpretation. Some future directions are indicated. Also the virtues of the K^+ and K^- as a nuclear probe are considered. 16 references. (JFP)

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

57308 (COO—1545-260) **Heavy quark production by neutrinos and antineutrinos.** Scott, D.M.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1979. Contract EY-76-C-02-1545. 12p. Dep. NTIS, PC A02/MF A01.

The rate for producing t- and b-quarks in, respectively, neutrino and antineutrino interactions with nucleons are estimated. Experimental quark parton distribution functions, SU(2) x SU(2) x U(1) gauge group mixing angles, and threshold suppression through rescaling are used in the calculation. The ratios to total cross sections of b-quark production by anti nu, R/sub b//sup anti nu/, and t-quark production by ν, R/sub t//sup nu/, are, respectively, R/sub b//sup anti nu/ approximately equal to 10^{-4} and R/sub t//sup nu/ approxi-

mately equal to 10^{-5} for an incident energy of 200 GeV. 13 references.

57309 (LA-UR—79-2616) **Symmetry violating kaon decays.** Herczeg, P. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 13p. (CONF-790847—11). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

An analysis of the muon number violating decay modes of the K-mesons is given. Subsequently, some new developments in the field of CP-violation are reviewed and the question of time-reversal invariance and the status of CPT-invariance are briefly considered. 42 references.

57310 **Limits on CP-invariance violation in K/sub mu3/ decays.** Schmidt, M.P.; Blatt, S.R.; Campbell, M.K.; Grannan, D.M.; Lauterbach, M.J.; Kasha, H.; Adair, R.K.; Morse, W.M.; Leipuner, L.B.; Larsen, R.C. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **43**: No. 8, 556-560(20 Aug 1979).

Measurements of the polarization of μ^+ from the decay of K/sub L/ ^{0} mesons gives a mean value of 0.0021 +- 0.0048 for the polarization in the direction (p/sub π/ x p/sub μ/) normal to the plane of decay. The ratio of the normal to the transverse polarization in the c.m. system is 0.0041 +- 0.0092 and the value of Imξ is deduced to be 0.012 +- 0.026, not significantly different from Imξ = 0.008 expected if the decay were invariant under CP (or T).

FIELD THEORY

REFER ALSO TO CITATION(S) 57294, 57303, 57304

57311 (COO—1764-363) **Soliton masses in supersymmetric theories.** Schonfeld, J.F. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy). 1979. Contract EY-76-C-02-1764. 59p. Dep. NTIS, PC A04/MF A01.

The semiclassical approximation - the familiar sum of frequencies - to the quantum-mechanical masses of solitons is ambiguous in theories with supersymmetric couplings: The approximation is unacceptably sensitive to the definition of the infinite-volume limit. The ambiguity can be resolved by means of a systematic mass-calculation procedure derived from the supersymmetry algebra. This method is applied to a large class of two-dimensional models, and finds that in 0(Dirac constant) the quantum-mechanical mass of a kink differs from its classical mass by a universal expression that has no dependence on the details of the interaction. The difference contains an ultraviolet divergence that exactly cancels the divergence in the classical mass. This contradicts recent claims that the difference must be zero. This result can also be checked using a number of other techniques, but it is argued that in space-times of dimension greater than two only the procedure derived from the supersymmetry algebra is likely to have any practical value. In two dimensions the difference between the quantum and classical masses can be related to properties of the amplitudes with which elementary bosons and fermions are scattered by a kink-antikink pair. Contrary to naive expectations these amplitudes are not identical; they nevertheless satisfy a supersymmetry Ward identity.

57312 **Improvement of an extrapolation scheme for strong-coupling expansion in quantum field theory.** Bender, C.M.; Cooper, F.; Guralnik, G.S.; Roskies, R.; Sharp, D.H. (Department of Physics, Washington University, St. Louis, Missouri 63130). *Phys. Rev. Lett.;* **43**: No. 8, 537-540(20 Aug 1979).

By letting the lattice spacing a approach zero as the order n of perturbation theory increases in such a way that the product na remains fixed, we substantially improve the numerical predictions. The approximation scheme described here is superior to conventional Pade approximation.

57313 **Quantum-chromodynamic β function at intermediate and strong coupling.** Kogut, J.B.; Pearson, R.B.; Shigemitsu, J. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **43**: No. 7, 484-486(13 Aug 1979).

With use of strong-coupling methods, the energy of a long flux string is computed and this quantity is used to renormalize the theory. This gives an expansion for the renormalization-group beta function which smoothly extrapolates from the strong-coupling limit to the asymptotic-freedom value. The theory is described by three qualitatively distinct regions over this range.

57314 **Color zitterbewegung.** Samuel, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., B;* **149**: No. 3, 517-524(26 Mar 1979).

The author discusses the proper procedure for a classical evaluation of a non-Abelian Wilson loop integral. The naive procedure is incorrect due to fluctuations in color, a phenomenon the author calls color zitterbewegung. A formalism for circumventing this complication is proposed. It is likely that the statistical mechanics of disorder theory is necessary in Wilson loop calculations.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 57208, 57370

57315 (ORNL—5485, pp 109-133) **Nuclear chemistry.** Feb 1979.

In Chemistry Division annual progress report for period ending August 31, 1978.

Topics covered include: mass asymmetry and total kinetic energy release in the spontaneous fission of ^{262}105; calculation of spontaneous fission properties of very heavy nuclei - 98 $\leq$ Z $\leq$ 106 and 150 $\leq$ N $\leq$ 164; energy losses for ^{84}Kr ions in nickel, aluminium and titanium; differences in compound nuclei formed with ^{40}Ar and ^{84}Kr projectiles; measurement of the energy division vs. mass in highly damped reactions; ambiguities in the inference of precompound emission from excitation function analysis; selective laser one-atom detection of neutral prompt fission fragments; laser induced nuclear polarization - application to the study of spontaneous fission isomers; quadrupole and hexadecapole deformations in the actinide nuclei; high-spin states in ^{164}Yb; contrasting behavior of h/sub 9/2/ and i/sub 13/2/ bands in ^{185}Au; multiple band crossings in ^{164}Er; recoil-distance measurement of lifetimes of rotational states in ^{164}Dy, lifetimes of ground-band states in ^{192}Pt and ^{194}Pt and application of the rotation-alignment model; coulomb excitation of vibrational nuclei with heavy ions; surface structure of deformed nuclei; valency contribution to neutron capture in ^{32}S; neutron capture cross section of manganese; search for superheavy elements in natural samples by neutron multiplicity counting; and gamma-ray studies on the geochemistry of achondritic meteorites. (GHT)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

57316 (LA—7892C, pp 150-166) **Elastic and charge exchange scattering of pions from the 3 and 4 nucleon system.** Landau, R.H. (Oregon State Univ., Corvallis). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Calculations describing pion elastic and charge-exchange scattering from three and four nucleon nuclei are described and a comparison with recent data are given. The calculations are based on a theoretical momentum space optical potential constructed from realistic nuclear form factors and πN t-matrices which incorporate the finite range of the two-body interactions. This first principle, parameter free theory provides (at least) qualitative agreement with both the elastic and charge exchange data. 25 references.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57317 (LA—7892C, pp 16-22) **Panofsky ratios.** Salomon, M. (Univ. of British Columbia, Vancouver). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

A summary is given of some recent TRIUMF results for the ratio of charge exchange and radiative capture of the negative pions at rest in nuclei. Charge exchange at rest is observed for the first time in ^{6}Li and ^{27}Al. 21 references.

57318 (LA—7892C, pp 174-176) **Pion single charge exchange on ^{3}He.** Cooper, M.D. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The LAMPF π^0 spectrometer was used to obtain ^{3}He(π^-,π^0)^{3}H charge exchange spectra at T/sub π^-/ = 200 MeV for the angles 0, 20, 40, 62, and 80 degrees. 4 references.

57319 **Determination of the asymptotic D- to S-state ratio of the deuteron wave function.** Conzett, H.E.; Hinterberger, F.; von Rossen, P.; Seiler, F.; Stephenson, E.J. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 8, 572-576(20 Aug 1979).

Cross sections and tensor analyzing powers in dp elastic scattering, measured at 35 and 45 MeV, are used to determine the asymptotic D- to S-state ratio of the deuteron wave function. The results agree with the value determined at lower energies and provide a considerably more precise averaged value: rho/sub D/ = 0.0263 +- 0.0013.

57320 **p-^{4}He elastic scattering at 788 MeV.** Fong, J.; Bauer, T.S.; Igo, G.J.; Pauletta, G.; Ridge, R.; Rolfe, R.; Soukup, J.; Whitten, C.A. Jr. (California Univ., Los Angeles (USA). Dept. of Physics); Hoffmann, G.W. (Los Alamos Scientific Lab., NM (USA)); Hintz, N. *Phys. Lett., B;* **78**: No. 2, 205-208(25 Sep 1978).

The p-^{4}He elastic cross section at 788 MeV has been measured for laboratory angles between 13.3° and 165.5° corresponding to a range of four-momentum-transfer, -t, from 0.11 to 4.19 GeV^2/c^2. Evidence is presented for a backward diffraction-like structure not previously observed (3.4<-t<4.22GeV^2/c^2). In the region 1.6<-t<-3.4GeV^2/c^2 a smooth fall off from the shoulder due to triple scattering is observed with no evidence for quadruple scattering.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

57321 **Neutron-proton radius differences and isovector deformations from π^+ and π^- inelastic scattering from ^{18}O.** Iversen, S.; Nann, H.; Obst, A.; Seth, K.K. (Northwestern Univ., Evanston, IL (USA)); Tanaka, N.; Morris, C.L.; Thiessen, H.A. (Los Alamos Scientific Lab., NM (USA)); Boyer, K.; Cottingame, W.; Moore, C.F. (Texas Univ., Austin (USA)). *Phys. Lett., B;* **82**: No. 1, 51-54(12 Mar 1979).

π^+ and π^- elastic and inelastic scattering from ^{18}O have been measured at T(π) = 164 MeV. Consistent with the results at 230 MeV, it is found that the ratio sigma(π^-)/sigma(π^+) for the 2_1^+ state is 1.86(16), while for the 3_1^- state it is 0.89(6). These results are interpreted as indicating differences in neutron and proton deformations characterizing the 2_1^+ transition and partial neutron blocking for the 3_1^- transition. Optical model analysis of elastic scattering leads to the conclusion that <r^{2}sub(n)>sup(1/2)-<r^{2}sub(p)>sup(1/2) = 0.03(3) fm.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57325, 57328, 57371

57322 **Interpretive model for ^{10}B.** Kurath, D. (Argonne National Lab., IL (USA)). *Nucl. Phys., A;* **317**: No. 1, 175-182(2 Apr 1979).

The observed features of electromagnetic transitions in ^{10}B are interpreted with a simplified model based on the dominance of the [42] representation in the relevant states.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57321

57323 (AED-Conf—78-007-000, pp 42-48) **Fusion of light ion systems at energies near and below the Coulomb barrier.** Arnould, M. (Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Kernphysik); Howard, W.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Cusson, R.Y. (Duke Univ., Durham, N.C. (USA). Dept. of Physics). 1978.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

Experimental fusion cross sections for light ion systems at energies belo v the Coulomb barrier become available in greater and greater number, and provide a stringent test of the macroscopic and microscopic physics involved in models of heavy-ion reactions. Measurements and predictions of the fusion cross sections for ^{12}C + ^{12}C, ^{12}C + ^{16}O and ^{16}O + ^{16}O are also of major importance in astrophysics.

57324 (LA—7892C, pp 53-65) **(π^+,π^0) and (p,n) excitations.** Sparrow, D.A. (Univ. of Pennsylvania, Philadelphia). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

There has been considerable interest in using charge-exchange reactions in the medium energy regime to study nuclear structure. This has been delayed by difficulties in understanding the experimental results even when the structure appears to be understood. As a result, even the limited data available in the past have prompted considerable efforts at going beyond a first order treatment. Initially, some of the features of (p,n) and (π^+,π^0) reactions are contrasted. Then the published (π^+,π^0) treatments will be briefly sketched. Finally, some calculations for mass-7 and mass-14 will be discussed, indicating the way in which pion or nucleon charge exchange may be a particularly fruitful tool. 24 references.

57325 (LA—7892C, pp 92-99) **Isovector vs isoscalar excitations in pion-nucleus inelastic scattering.** Siciliano, E.R. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Microscopic distorted-wave impulse approximation calculations of pion inelastic scattering off of J = T = 0 nuclei are discussed. It is shown how the isospin 3/2 dependence of the basic πN amplitude tends to favor isoscalar transitions to high-spin states over isovector transitions to the corresponding states. These results along with recent ^{12}C(π,π')^{12}C* data from LAMPF are used to position the T = 0, 4$^-$ state in ^{12}C to be within a few hundred keV of the T = 1, 4$^-$ state at 19.6 MeV. 12 references.

57326 (LA—7892C, pp 343-351) **Semiclassical theory for pion single and double charge exchange to analog states.** Johnson, M.B. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Analytic expressions are derived for angular distributions for pion single and double charge exchange to analog states. The theory is valid only in the region of the (3-3) resonance and explicates the relation to elastic scattering and nuclear structure. The angular distributions are manifestly sensitive to the difference between the neutron and proton densities in the nuclear surface, especially in the case of double charge exchange. The angular dependence of the cross sections is characterized by a nuclear radius R which corresponds to the 10% to 20% density point. 6 references.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57328, 57330, 57331, 57333, 57334, 57335, 57341

57327 (LA—7892C, pp 85-91) **Comparison of isoscalar and isovector transitions induced in π^+ inelastic scattering near 180 MeV.** Thiessen, H.A. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Ratios are reported for the excitation of the 1$^+$ T = 0(1), 12.7 (15.1) MeV states in ^{12}C and the 6$^-$ T = 0(1), 11.58 (14.36) MeV states in ^{28}Si using π^+ inelastic scattering measured at the EPICS facility at LAMPF. The observed ratios of T = 0 to T = 1, 1.4 +- 0.8 for ^{12}C and 1.5 +- 0.2 for ^{28}Si are inconsistent with the prediction of Gupta and Walker of 4.0 for states of different isospin but otherwise identical structure. 11 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57317, 57327, 57341, 57361

57328 (COO—2490-10) **Study of structure of nuclei with neutrons and nuclear data measurements for MFE. Progress report, September 1, 1978-August 31, 1979.** Lane, R.O. (Ohio Univ., Athens (USA)). 1979. Contract EY-76-S-02-2490. 73p. Dep. NTIS, PC A04/MF A01.

Measurements of neutron inelastic scattering cross sections for ^{7}Li(n,n')^{7}Li* (0.478 MeV) made at this Laboratory together with our earlier elastic scattering results have been analyzed in terms of our new multilevel-multichannel R-Matrix calculation. The investigation has led to the assignment of many more levels in ^{8}Li than were previously known with confidence. These results are in good agreement with recent theoretical model calculations, so that together the two provide considerable advancement in the state of our knowledge of ^{8}Li, the knowledge of which has stood virtually motionless for two decades. Inelastic differential cross sections have been measured from 4.8 to 6.5 MeV for ^{11}B and ^{13}C over part of the resonance region of each nucleus. These form the initial portion of a comprehensive study of the compound nuclei ^{12}B and ^{14}C using inelastic and elastic data in a multichannel-multilevel R-Matrix analysis. The construction and optimization testing of the triplet quadrupole spectrometer for study of (n,z) reactions are essentially completed. Performance tests show that design characteristics of solid angle and resolution have been achieved. Initial measurements with the spectrometer to study the neutron-neutron final state interactions in the D(n,p)nn reaction at E/sub n/ = 9 and 11 MeV, and measurements of the elastic scattering of neutrons by deuterium by observation of the recoil deuterons with the spectrometer is now underway. These results are preliminary to the (n,z) measurements on structural and tritium-breeding elements of fusion reactor designs.

57329 (LA—7892C, pp 100-107) **Fixed scatterer approach to pion single charge exchange.** Gibbs, W.R. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Calculations of pion single charge exchange on ^{7}Li, ^{10}B, and ^{12}C are described and results are presented. 10 references.

57330 (LA—7892C, pp 167-173) **Differential cross section measurements for ^{7}Li(π^{+},π^{0})^{7}Be and ^{12}C(π^{+},π^{0})^{12}N.** Doron, A.; Alster, J.; Gilad, S. (Tel Aviv Univ., Israel). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Experimentally measured angular distributions are presented for the reactions ^{13}C(π^{+},π^{0})^{13}N (IAS) and ^{7}Li(π^{+},π^{0})^{7}Be (g.s. + 0.429 MeV) at T/sub π/ = 150 MeV. The data were obtained with the π^{0} spectrometer. The experimental cross sections are larger than calculations, by factors of 2 to 3. Also presented are the excitation function for ^{13}C(π^{+},π^{0})^{13}N (IAS) at theta = 5^{0} for T/sub π^{+}/ = 70 MeV to 180 MeV. The data do not agree with calculations. All our present differential cross sections seem to be consistent with previously measured angle-integrated cross sections. 11 references.

57331 (LA—7892C, pp 177-182) **(π^{+},π^{0}) IAS transitions in heavy nuclei.** Cverna, F. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The first results are reported of measurements on the (π^{+},π^{0}) reaction in order to search for the isobaric analog state in pion charge exchange on nuclei throughout the periodic table, namely lithium-7, carbon-13,aluminium-27, nickel-58, zirconium-90, tin-120, and lead-208. 7 references. (JFP)

57332 (LA—7892C, pp 194-200) **Pion double charge exchange.** Cooper, M.D. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The pion double charge-exchange data on the oxygen isotopes are reviewed and new data on ^{9}Be, ^{12}C, ^{24}Mg, ^{26}Mg, and ^{28}Si are presented. Where theoretical calculations exist, they are compared to the data. 9 references.

57333 (LA—7892C, pp 314-318) **Total cross sections for (γ,π^{-}) reactions in the Δ region.** Bosted, P.E.; Blomqvist, K.I.; Bernstein, A. M. (Massachusetts Inst. of Tech., Cambridge). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Total cross sections for ^{12}C(γ,π^{-})^{12}N and ^{7}Li(γ,π^{-})^{7}Be were measured from threshold to 350 MeV photon energy by detecting the radioactivity of the residual nuclei. The observed final states are the lowest state of ^{12}N and the ground and first excited states of ^{7}Be. The observed cross sections peak at approximately 50 MeV over threshold and then drop rapidly. The measured cross section for ^{12}C(γ,π^{-})^{12}Nis fairly well reproduced by DWIA calculations. 13 references.

57334 (LA—7892C, pp 319-325) **Electroproduction of charged pions from ^{12}C to discrete final nuclear states.** Bernstein, A.M.; Paras, N.; Blomqvist, K.I. (Massachusetts Inst. of Tech., Cambridge). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The charge exchange reaction, π^{+-} electroproduction from ^{12}C, was studied at 90^{0} for T/sub π/ ≅ 17 and 29 MeV. Transitions to discrete final states in ^{12}B and ^{12}N were observed up to 4.5-MeV excitation energy. The results are analyzed using virtual photon theory. The resulting photoproduction cross sections are in reasonable agreement with recent theoretical calculations. 15 references.

57335 (LA—7892C, pp 326-338) **Experimental test of pion exchange and PCAC in proton-nucleus charge exchange reactions at 144 MeV.** Moake, G.L. (Purdue Univ., West Lafayette, IN); Debevec, P.T.; Gutay, L.J.; Quin, P.A.; Scharenberg, R.P. Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The differential cross sections of the (p,n) reaction on ^{6}Li, ^{12}C, and ^{14}N to the ground state of the final nuclei at E/sub p/ = 144 and 0 < theta/sub LAB/ < 20^{0} were measured. The quantum numbers of these transitions, like those in Gamow-Teler beta decay, have ΔJ = 1, ΔT = 1, and ΔP = 0, which is consistent with the one-pion exchange mechanism. Differential cross sections were calculated with the absorption modified one-pion exchange model. The nucleus was treated as an elementary particle, as first suggested by Kim and Primakoff. Using the partially conserved axial vector current hypothesis (PCAC) the magnitude and momentum dependence of the initial nucleus-pion-final nucleus coupling constant, g/sub NπN'/, was obtained from beta decay and inelastic electron scattering, respectively. The calculations, which had no free parameters, were found to agree with the data for ^{6}Li and ^{12}C, but not for ^{14}N. 14 references.

57336 (LA-UR—79-2430) **Pion double-charge exchange across the (3,3) pi-nucleon resonance.** Green, S.J.; Holtkamp, D.B.; Cottingame, W.B.; Braithwaite, W.J.; Moore, C.F.; Burleson, G.R.; Blanpied, G.S.; Morris, C.L.; Thiessen, H.A. (Texas Univ., Austin (USA); New Mexico State Univ., Las Cruces (USA); Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 12p. (CONF-790847—10). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

Pion double charge exchange reactions were studied across the (3,3) π-nucleon resonance. The reactions^{16} ^{18}O(π^{+},π^{-})^{18} ^{18}Ne and ^{24,26}Mg(π^{+},π^{-})^{24,26}Si were studied from 100 MeV to 300 MeV. Energy excitation functions of dσ/dΩ are reported for all targets. Also presented are angular distributions of dσ/dΩ for ^{18}O and ^{26}Mg. 13 references.

57337 (ORNL—5575) **O(n,xγ) reaction cross section for incident neutron energies between 6.5 and 20.0 MeV.** Morgan, G.L.; Chapman, G.T. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 37p. Dep. NTIS, PC A03/MF A01.

Differential cross sections for the neutron-induced gamma-ray production from oxygen were measured for incident neutron energies between 6.5 and 20.0 MeV. The Oak Ridge Electron Linear Accelerator (ORELA) was used to provide the neutrons and a NaI spectrometer to detect the gamma rays at 125°. The data presented are the double differential cross section, $d^{2}\sigma/d\Omega dE$, for gamma-ray energies between 1.6 and 10.6 MeV for coarse intervals in incident neutron energy. The integrated yield for gamma rays of energies greater than 1.6 MeV with higher resolution in the neutron energy is also presented. The experimental results are compared with the Evaluated Nuclear Data File (ENDF). 34 references.

57338 **Measurement of the reactions ^{9}Be(p,π^{+-}) at 800 MeV.** Hoeistad, B.; Adams, G.S.; Gazzaly, M.; Igo, G.; Irom, F.; Nann, H. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* 43: No. 7, 487-490(13 Aug 1979).

Angular distributions from the (p,π^{+}) and (p,π^{-}) reactions on ^{9}Be leading to discrete isobaric analog states in ^{10}Be and ^{10}C have been measured at 800 MeV over the momentum-transfer interval 600—800 MeV/c. The ratio between the (p,π^{+}) and (p,π^{-}) production cross sections is found to be much larger at 800 MeV than at lower energy. The angular distributions from the (p,π^{-}) reaction show a pronounced slope not observed in previous data.

57339 **Microscopic description of 800-MeV polarized-proton scattering from ^{16}O.** Adams, G.S.; Bauer, T.S.; Igo, G.; Pauletta, G.; Whitten, C.A. Jr.; Wriekat, A.; Hoffmann, G.W.; Smith, G.R.; Gazzaly, M.; Ray, L.; Love, W.G.; Petrovich, F. (Physics Department, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* 43: No. 6, 421-424(6 Aug 1979).

Differential cross sections and analyzing powers have been measured for elastic and inelastic scattering of 800-MeV protons by ^{16}O. Microscopic analyses utilizing the impulse approximation are used to study the ground-state neutron distribution of ^{16}O, and to demonstrate the importance of the spin-orbit amplitudes for the inelastic transitions.

57340 **Observation of enhanced excitation of ^{12}C by inelastic pion scattering on the (3,3) pion-nucleon resonance.** Moore, C.F.; Cottingame, W.; Boyer, K.G.; Smith, L.E.; Harvey, C.; Braithwaith, W.J. (Texas Univ., Austin (USA)); Morris, C.L.; Thiessen, H.A.; Amann, J.F. (Los Alamos Scientific Lab., NM (USA)); Devereux, M. *Phys. Lett., B;* 80: No. 1, 38-40(18 Dec 1978).

Pion inelastic scattering on ^{12}C to states at an excitation energy of approximately 19 MeV shows a strong enhancement at an incident pion energy near the pion-nucleon (3,3) resonance. This resonance may therefore provide a mechanism for the selective enhancement of inelastic transitions.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

REFER ALSO TO CITATION(S) 57326, 57366

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57327, 57331, 57341

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57327, 57331, 57332

57341 (LA—7892C, pp 201-221) **Pion double charge exchange.** Seth, K.K. (Northwestern Univ., Evanston, IL). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The (π^+,π^-) and (π^-,π^+) reactions are studied on oxygen-18, carbon-9, and carbon-12 at 164 MeV. The differential cross sections and angular distributions are shown and discussed. 36 references. (JFP)

57342 **In-beam nuclear gamma-ray studies of relativistic heavy-ion reactions.** Shibata, T.; Ejiri, H. (Osaka Univ., Toyonaka (Japan). Dept. of Physics); Chiba, J.; Nagamiya, S.; Nakai, K. (Tokyo Univ. (Japan). Dept. of Physics); Anholt, R.; Bowman, H.; Ingersoll, J.G.; Rauscher, E.A.; Rasmussen, J.O. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Phys., A;* **308**: No. 3, 513-531(9 Oct 1978).

Discrete nuclear γ-rays following interactions of relativistic ^{12}C and α projectiles with Sr, Na, S and Ca targets were measured in-beam with Ge(Li) detectors. The observed γ-rays were due mostly to the first excited-state-to-ground transitions of target fragments produced in peripheral collisions of the heavy ions. Characteristic features of the peripheral process consistent with the projectile-fragment studies were observed. The general behavior of the reactions was qualitatively understood with a picture of a fast-cascade followed by evaporation.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

57343 (LA—7892C, pp 267-285) **Status and recent results with nucleon probes.** Ray, L. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Some recent results of Kerman, McManus, and Thaler optical potential analyses of 0.8 GeV polarized proton elastic scattering data on a wide range of target nuclei are presented. Second order corrections due to target nucleon correlations and electromagnetic effects are discussed and are included in the analysis presented. Neutron radii and density distributions deduced from the 0.8 GeV proton elastic data are compared with the results of analyses of 1.0 GeV proton scattering data and with Hartree-Fock predictions. Approximately model-independent forms for the neutron densities are obtained and are compared with theoretical calculations. Good agreement with Hartree-Fock predictions is attained in most cases. 49 references.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57343, 57371

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57326

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57331

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57331, 57342

57344 **Backward angle heavy ion elastic scattering on ^{40}Ca and ^{58}Ni.** Kubono, S.; Bond, P.D.; Thorn, C.E. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Lett., B;* **81**: No. 2, 140-142(12 Feb 1979).

The excitation functions of elastic scattering at 180° for $^{16}O + {}^{40}Ca$ and $^{12}C + {}^{40}Ca$ are observed to oscillate between sigma/sigmasub(R) = 10^{-3} and 10^{-4} over a wide range of energies; the $^{16}O + {}^{58}Ni$ system shows a monotonic decrease to a value of sigma/sigmasub(R) = 10^{-5} over the energy range studied.

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 57343

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57343

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

57345 (AED-Conf—78-007-000, pp 161-168) **Studies of evaporation residue products from krypton and argon reactions.** Plasil, F.; Ferguson, R.L. (Oak Ridge National Lab., Tenn. (USA)); Britt, H.C.; Erkkila, B.H. (Los Alamos Scientific Lab., N.Mex. (USA)); Blann, M. (Rochester Univ., N.Y. (USA)); Gutbrod, H.H. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

Mass distributions of evaporation residue (ER) products from ^{86}Kr-bombardments of ^{70}Ge and ^{74}Ge have been obtained by a time-of-flight method at energies ranging from the interaction barrier to 706 MeV. ER excitation functions have also been obtained for a variety of target and projectile combinations. Results are compared with statistical model calculations and with results obtained from γ-measurements. It is deduced that at the lowest impact parameters the reaction products belong to the ER group, in contrast with the angular momentum hypothesis of Lefort. Cross sections were found to be consistent with an angular momentum limit arising from the onset of fission.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 57343

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57343

57346 **Giant E0 resonances and their effects on the lifetime of excited 0^+ states.** Castel, B.; Satchler, G.R. (Oak Ridge National Lab., TN (USA)). *Phys. Lett., B;* **80**: No. 1, 13-16(18 Dec 1978).

The renormalization effects on low-energy EO transitions due to excitation of giant EO resonances are investigated. The introduction of a state-dependent monopole effective charge improves greatly agreement with experiment in the cases where comparison with two-particle shell-model calculations are possible.

MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 57347

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57326, 57355

57347 **Verifications of the Lane-Lynn theory of direct neutron capture.** Mughabghab, S.F. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Lett., B;* **81**: No. 2, 93-97(12 Feb 1979).

Quantitative and detailed comparison between the Lane-Lynn theory of direct capture of thermal neutrons and experimental values shows exceptional agreement for a large body of data in the mass regions around 40 and 140. The $^{136}Xe(n,\gamma)^{137}Xe$ reaction is used to verify the theory. Other examples are also given to illustrate the ability of the theory to predict capture cross sections, coherent-scattering lengths, spins of final states, and (d,p) spectroscopic factors.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 57360

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57350, 57351

57348 (LA—7892C, pp 66-84) **Isospin in giant resonances: recent advances.** Paul, P. (State Univ. of New York, Stony Brook). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Recent experimental developments on electric giant multipole resonances are discussed with emphasis on isovector excitation. The very complete investigation of isoscalar resonances supports model predictions and, by consistency, lends credence to an increasing body of data on isovector excitations obtained from inelastic electron scattering. Recent developments in the isovector Lane potential, isospin splitting, and isospin mixing are also presented. 36 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57342, 57367

57349 (COO—3496-72) **Studies of heavy ion reactions and transuranic nuclei. Progress report, September 1, 1978-August 31, 1979.** Huizenga, J.R. (Rochester Univ., NY (USA). Dept. of Chemistry and Physics). Aug 1979. Contract EY-76-S-02-3496. 261p. Dep. NTIS, PC A12/MF A01.

Experimental research on heavy ion reactions is summarized. A list of publications is included. (JFP)

57350 (LA—7892C, pp 11-15) **Pion single charge exchange program at LAMPF.** Bowman, D. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

A brief discussion is given of how the spectrometer works and its capabilities. The physical programs carried out in the first data runs are outlined as well as ideas for future work. Plots are presented for the on-line spectrum for zirconium 90 with the clearly visible analog state, which occurs at an excitation of 5 MeV in ^{90}Nb and for the neutral pion kinetic energy spectrum obtained in December, 1978. (JFP)

57351 **Angular momentum selection using total gamma-ray energies.** Koerner, H.J.; Hillis, D.L.; Roulet, C.P.; Aguer, P.; Ellegaard, C.; Fossan, D.B.; Habs, D.; Neiman, M.; Stephens, F.S.; Diamond, R.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 7, 490-494(13 Aug 1979).

Use of a total γ-energy spectrometer in coincidence with a variety of detectors has led to the observation of the highest multiplicities yet achieved for compound nuclear products, allowing for the selection and study of high angular momentum states. A differential comparison of coincident γ spectra corresponding to slices of the total-energy spectrum yields a direct evaluation of the moment of inertia for a rotational nuclear structure.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 57352

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57331

57352 **Single-proton states in ^{157}Eu and ^{159}Eu studied with the (t(pol),α) reaction.** Burke, D.G. (McMaster Univ., Hamilton, Ontario (Canada). Tandem Accelerator Lab.); Loevhoeiden, G. (Bergen Univ. (Norway)); Flynn, E.R.; Sunier, J.W. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Phys., A;* **318**: No. 1-2, 77-96(16 Apr 1979).

No nuclear structure information is available in the literature for the neutron-rich isotope ^{159}Eu and there is conflicting evidence concerning the decay of ^{157}Sm to levels in ^{157}Eu. The present report describes /sup 158, 160/Gd(t(pol/,α)sup/ 157, 159)Eu results which provide a great deal of information on these nuclides. The experiments were performed with 17 MeV polarized tritons from the tandem Van de Graaff accelerator at the Los Alamos Scientific Laboratory. The reaction products were analyzed with a Q3D magnetic spectrometer and detected with a helical-cathode position-sensitive counter. A new, more accurate value for the mass of ^{159}Eu has been obtained. A comparison of the measured angular distributions of (t,α) cross sections and analyzing powers with DWBA predictions permitted the determination of spins and parities for many levels. Rotational bands have been assigned for the 5/2$^+$[413], 5/2$^-$[532], 3/2$^+$[411] and 1/2$^+$[420] orbitals in each nuclide. Also I/ sup π/ =3/2$^+$ levels have been found which are probably members of the 1/2$^+$[411] bands. The availability of this type of information makes it possible to extend the systematics of single particle states, and some interesting trends are discussed.

57353 **Stability of a ground-state rotational structure for the transitional nucleus ^{152}Eu.** Lanier, R.G.; Struble, G.L.; Mann, L.G.; Proctor, I.D.; Heikkinen, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Phys. Lett., B;* **78**: No. 2, 217-220(25 Sep 1978).

Proton scattering from ^{152}Eu reveals a well-behaved ground-state rotational structure. This result emphasizes the strong influence of the hsub(1/2) orbital in the A approximately 150 region and is intimately connected with possible shape coexistence in ^{153}Eu.

57354 **Nuclear levels in ^{152}Eu.** von Egidy, T.; Kaiser, W.; Mampe, W.; Hillenbrand, C.; Stoeffl, W. (Technische Univ. Muenchen (Germany, F.R.)); Lanier, R.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Muehlbauer, K.; Schult, O.W.B.; Koch, H.R.; Baader, H.A. (Technische Univ. Muenchen (Germany, F.R.). Eggenstein-Leopoldshafen, Germany, F.R.; ZAED (May 1978). 141p.

The transitional nucleus ^{152}Eu has been studied using the (n,e), (n,γ), (nsub(res),γ), (n,$\gamma\gamma$), (d,p), (d,t) and (p,d) reactions. The experiments have been performed at nine different laboratories. A model independent level scheme was established including 95 levels below 510 keV and nearly 900 transitions by combination of low energy transitions and reaction data. More than 20 additional levels result from gamma rays and/or charged particle reactions. The level scheme is interpreted in terms of the Nilsson model indicating that ^{152}Eu is a deformed nucleus. Seven rotational bands and Nilsson configurations are established. An additional 27 rotational bands are tentatively or speculatively assigned. Gallagher-Moszkowski splittings are discussed. The neutron binding energy was determined as 6305.2 +- 0.5 keV. The energy of the 9.3 h0$^-$ isomer is 45.599 keV. The lifetimes of four levels were measured.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57331, 57352, 57353

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 57343

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57343, 57346

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57326, 57366

57355 (LA—7892C, pp 108-118) **Pion single charge-exchange reactions with heavy nuclear targets.** Miller, G.A. (Univ. of Washington, Seattle). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

Distorted wave calculations of single charge-exchange cross sections are explained and results are presented. It is found that the use of optical potentials that are consistent with elastic scattering data is extremely important in predicting cross sections for the (π^+,π^0) reaction. 11 references.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

57356 **γ-ray intensities from ^{197}Hg (64 h) decay.** Helmer, R.G.; Gehrke, R.J. (Idaho National Engineering Lab., Idaho Falls (USA)). *Int. J. Appl. Radiat. Isot.;* **30**: No. 1, 15-18(Jan 1979).

The relative γ-ray intensities for the decay of ^{197}Hg (64 h) have been measured to be 100.0(20), 3.38(11) and 0.21(1) for the 77, 191 and 268 keV γ-rays. The absolute intensity of the 77 keV γ-ray is computed to be 18.1%.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57331

57357 **Levels and γ-ray transitions in ^{190}Os, a perturbed O(6) nucleus.** Casten, R.F.; Macphail, M.K.; Kane, W.R.; Breitig, D.; Cizewski, J.A. (Brookhaven National Lab., Upton, NY (USA)); Schreckenbach, K. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)). *Nucl. Phys., A;* **316**: No. 1-2, 61-92(1979).

Levels up to 2.5 MeV in ^{190}Os have been studied with the (n, γ) and (n, e$^-$) reactions at thermal and resonance energies. Transition multipolarities were deduced from the measured conversion

coefficients and from L- and M-subshell ratios. Due to the nature of the (n, γ) reaction, the level scheme developed stresses low spin states and is complementary to those already existing based on the (α, xn) reaction and on β-decay from high spin parent states. The level populations are shown to lead to a new use of population systematics to extract nuclear structure information. The remarkable decay characteristics of the excited O^+ states are also studied and explained as a natural consequence of the interacting boson approximation model of Arima and Iachello. The full set of positive parity levels below the pairing gap is interpreted in terms of this model, specifically, in terms of the transition from the O(6) limit characterizing ^{196}Pt toward the deformed symmetric rotor limit.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57331

57358 Wide-angle high-energy proton spectra by 800 MeV/A C, Ne, and Ar beams. Nagamiya, S.; Anderson, L.; Brueckner, W.; Chamberlain, O.; Lemaire, M.C.; Schnetzer, S.; Shapiro, G.; Steiner, H.; Tanihata, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **81**: No. 2, 147-150(12 Feb 1979).

Inclusive proton spectra, as well as two-particle correlations, resulting from collisions between energetic nuclei have been measured. Protons associated with large momentum transfers show exponential-type energy distributions having a decay constant about (70-90 MeV)$^{-1}$. For light-mass targets a strong two-particle correlation has been observed, which is kinematically consistent with quasi-elastic pp scatterings.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 57361

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57362, 57363

57359 Search for volatile superheavy elements from the reaction ^{248}Cm + ^{48}Ca. Illige, J.D.; Hulet, E.K.; Nitschke, J.M.; Dougan, R.J.; Lougheed, R.W.; Ghiorso, A.; Landrum, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Phys. Lett., B;* **78**: No. 2, 209-212(25 Sep 1978).

The authors have extended the search for superheavy elements in an experiment designed to condense and detect volatile superheavy elements with half-lives between one and 10^7 s. None were detected, however, a large region of very low cross sections and short half-lives remains unexplored.

SPONTANEOUS AND INDUCED FISSION

57360 (IAEA—213, pp 677-741) **Integral determination of fission product inventory and decay power.** Schenter, R.E.; Schmittroth, F. (Hanford Engineering Development Lab., Richland, WA (USA)); England, T.R. (Los Alamos Scientific Lab., NM (USA)). 1978.

From Meeting on fission product nuclear data; Petten, Netherlands (5 Sep 1977).

Results from nine recent integral decay heat experiments are presented and compared with summation calculations made with several fission product data libraries. Significant improvement has resulted in the agreement between experiments and the comparisons to calculations since last reviewed at the Bologna meeting. Comparisons with experiments are also given for β and γ spectra calculations applying the summation method and using the ENDF-IV decay data library. Generalized least-squares methods are applied to the recent decay-heat experiments and summation calculations to arrive at evaluated values and uncertainties. Results for thermal fission of ^{235}U imply uncertainties less than 2% (1 sigma) for the "infinite" exposure case for all cooling time greater than 10 seconds. In addition, related topics such as gas content in fission products, absorption effects on decay heating, absorption buildup in reactors, photoneutron spectra, summation calculation uncertainties and analytical representations of decay power are reviewed.

57361 (ORNL/TM—6832) **Measurement of ^{238}U(n,n'γ) and ^{7}Li(n,n'γ) gamma-ray production cross sections.** Olsen, D.K.; Morgan, G.L.; McConnell, J.W. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 120p. Dep. NTIS, PC A06/MF A01.

Time-of-flight techniques and a 95-cm^3 Ge(Li) detector positioned 20 m from the ORELA white neutron source have been utilized to measure 125° cross sections for the production of gamma rays in ^{238}U and ^{7}Li samples by 0.48 to 5.0-MeV neutrons. The incident neutron flux was determined with a proton-recoil telescope which used a solid-state, recoil-proton detector. Altogether, 28 cross sections for ^{238}U transitions from levels with 680 to 1224 keV of excitation were measured. In addition, 7 branching ratios for weak ^{238}U transitions and the ^{7}Li(n,n'γ)^{7}Li* (478 keV) cross section were measured. From these data and other level-decay information, preliminary neutron inelastic scattering cross sections were constructed and compared with those at 680, 732, 827, 965, 1048, and 1170-keV of excitation from the proposed ENDF/B-V evaluation. 40 references.

57362 Observation of isoscalar giant-resonance structure in the fission of ^{238}U following inelastic scattering of ^{6}Li. Shotter, A.C.; Gelbke, C.K.; Awes, T.C.; Back, B.B.; Mahoney, J.; Symons, T.J.M.; Scott, D.K. (Physics Department, University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom). *Phys. Rev. Lett.;* **43**: No. 8, 569-572(20 Aug 1979).

Resonance structures are observed in the region of the isoscalar giant quadrupole resonance for the reaction ^{238}U(^{6}Li, ^{6}Li'f) at 150 MeV. The ratio between the fission probabilities of resonance and compound-nucleus components appears to be greater than the recently reported value from (α,α') scattering.

57363 Scenario for the 220-MeV ^{40}Ar + ^{238}U reaction. Mathews, G.J.; Sobotka, L.G.; Wozniak, G.J.; Regimbart, R.; Schmitt, R.P.; Rattazzi, G.U.; Moretto, L.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Z. Phys., A;* **290**: No. 4, 407-409(1979).

Singles and coincidence charge distributions are combined to illustrate the mechanism for the 220-MeV ^{40}Ar + ^{238}U reaction. It is found that the apparent peak in the coincidence fragment distribution corresponding to Z = 82 (A=208) can be explained in terms of the fissionability of the target-like fragments produced in deep-inelastic collisions rather than as a manifestation of shell effects in compound-nucleus fission, as has been postulated for a similar system.

NUCLEAR THEORY

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 57307

57364 (LA—7892C, pp 286-297) **Measuring neutron and proton densities with pions.** Ernst, D.J. (Texas A and M Univ., College Station). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The possibility of measuring neutron and proton matter distributions in finite nuclei is discussed. The use of elastic π^+ and π^- scattering and single charge exchange to the analogue state are examined. Some simple phenomenological models that clarify which region of the densities are sensitive to pion scattering are presented. A review of the microscopic theory of pion elastic scattering is given. Charge symmetry is used to derive relations between the elastic scattering of pions and charge exchange to the analogue state. 31 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 57307, 57364

57365 (AED-Conf—78-007-000, pp 132-136) **Fission and heavy-ion reactions.** Moeller, P.; Nix, J.R. (Los Alamos Scientific Lab., N.Mex. (USA). Theoretical Div.). 1978.

From 6. workshop on gross properties of nuclei and nuclear excitations; Hirschegg, Austria (15 Jan 1978).

In collective models for the dynamics of nuclear fission and heavy-ion reactions the equations of motion contain three terms: the potential energy, the kinetic energy and a dissipative term. We shall here focus our attention on the kinetic energy, which is often expressed in terms of the mass or inertia associated with the nuclear motion. The most commonly used microscopic model for the nuclear inertia is the cranking model of Inglis. This model is at the present time not well understood. It has, however, been applied to many problems in fission and heavy-ion reactions. To gain some additional understanding of the cranking model we shall here briefly discuss some results obtained in Los Alamos during the past year. We consider a doubly closed-shell nucleus in a deformed spheroidal harmonic-oscillator single-particle potential plus a small perturbation.

57366 (CONF-790743—5) **Central collisions in intermediate energy heavy-ion reactions.** Wong, C.Y. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

From Symposium on heavy ion physics from 10-200 MeV/A; Upton, NY, USA (16 Jul 1979).

The critical collisions in intermediate energy heavy-ion reactions are examined from both a microscopic and macroscopic viewpoint. In the microscopic description the proper tool is the extended TDHF approximation involving both the mean field and the particle collisions. To understand the underlying physics, the effect of the mean field and the effect of particle collisions are studied separately. It is found that th sudden increase in the density of the overlapping region can cause the volcano effect, leading to the complete disintegration of one of the nuclei. The self-consistent mean field also gives rise to the bunching instability when the two Fermi spheres of the colliding nucleons separate. The collision between nucleons, on the other hand, leads to irreversible dissipation, thermalization, and the possibility of a hydrodynamical description of the dynamics. Next is studied the dynamics of central collisions using the hydrodynamical description for many combinations of targets and projectiles at different energies. The formation of shock waves, sidesplash, and the complete disintegration of the whole nucleus are examined. Nuclear viscosity is found to affect the angular distribution of the reaction products and also the maximum compression ratio achieved during the collision. 28 references.

57367 (LA—7892C) **LAMPF workshops on pion single charge exchange.** Baer, H.; Bowman, D.; Johnson, M. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 366p. (CONF-790126—). Dep. NTIS, PC A16/MF A01.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

The workshop contained 29 papers, four of which appeared previously in ERA. Separate abstracts were prepared for 25 papers. (JFP)

57368 (LA—7892C, pp 339-342) **Is the quasielastic pion cross section really bigger than the pion-nucleus reaction cross section.** Silbar, R.R. (Los Alamos Scientific Lab., NM). Jul 1979.

From LAMPF workshop on Pion Single Charge Exchange; Los Alamos, NM, USA (22 Jan 1979).

It is shown that soft pion charge exchanges may increase the inclusive (π^+,π^0) cross section, relative to the total quasielastic $(\pi^+,\pi^{+\prime})$ cross section, by as much as a factor of two. 4 references.

57369 (LBL—8931) **Towards relativistic heavy ion collisions by small steps towards the stars.** Scott, D.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 91p. Dep. NTIS, PC A05/MF A01.

A review lecture is given on current attempts to search for the exotic processes occurring in relativistic heavy ion collisions. From peripheral collisions the discussion proceeds to central collisions and lastly the search for the exotic, in which the tools developed for the study of peripheral and central collisions are used. 200 references. (JFP)

57370 (UCRL—50400(Vol.21)(Pt.C)) **Integrated system for production of neutronics and photonics calculational constants. Volume 21, Part C, Program SIGMAL (version 79-1): Doppler-broaden evaluated cross sections in the Livermore-Evaluated Nuclear Data Library (ENDL) format.** Cullen, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1979. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

A code, SIGMAL, to Doppler-broaden evaluated cross sections in the ENDL format was designed. This code can Doppler-broaden cross sections that result from neutrons, protons, deuterons, tritons, ^{3}He, or alpha particles incident on any target nuclei. The code allows broadening to up to 100 final temperatures, either directly from the initial temperature or by bootstrapping to successively higher temperatures. 6 figures, 2 tables.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 57365

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 57365

57371 **Adiabatic analysis of time-dependent Hartree-Fock solutions in the testing case of vibrating nuclei.** Bonche, P. (California Inst. of Tech., Pasadena (USA). W.K. Kellogg Radiation Lab.); Doubre, H. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire); Quentin, P. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B:* 82: No. 1, 5-8(12 Mar 1979).

The Baranger-Veneroni chi operator is extracted from TDHF solutions describing monopole and quadrupole isoscalar vibrations of the ^{16}O and ^{40}Ca nuclei. As function of time, the eigenvalues of chi behave as well-known RPA solutions. The adequacy of the adiabatic expansion as a powerful analyzing tool of collective motions in a TDHF calculation is demonstrated in this testing case.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

57372 **Z_1^3 contribution to the energy loss of heavy charged particles.** Morgan, S.H. Jr.; Sung, C.C. (Program Development, George C. Marshall Space Flight Center, Huntsville, Alabama 35812). *Phys. Rev., A;* 20: No. 3, 818-824(Sep 1979).

The Z_1^3 contribution of distant collisions to the average energy loss of heavy charged particles is obtained by extending Bethe's quantum-mechanical calculation to the next highest order in Z_1. The second-order Born approximation for the inelastic-collision cross section is simplified by using two major approximations. The infinite summation over terms arising from the coupling to intermediate states of the target atom is approximated with the aid of a parameter and the closure relation. This parameter is proportional to the average excitation energy of the intermediate states as described in the literature. The atomic form factors are simplified through a dipole expansion. Results are obtained in terms of an average excitation energy of the medium. Exemplary results for stopping in Al are presented for estimated values of the average excitation energy of the intermediate states. These results approach the classical and experimental values as the velocity of the penetrating particle increases, agreeing within 20% at $\beta=0.3$.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 56555, 57328, 57376, 57379

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 56909

57373 (BNL—26610) **Phonon scattering in metallic glasses.** Black, J.L. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 9p. (CONF-790862—3). Dep. NTIS, PC A02/MF A01.

From 3. international conference on phonon scattering in condensed matter; Providence, RI, USA (28 Aug 1979).

The purpose of this article is to review some recent theoretical and experimental developments in the study of metallic glasses at temperatures near or below 1K. In this temperature regime, it appears that practically all glasses, whether metallic or insulating, behave in a similar fashion. The fact that such similarities occur, despite substantial structural differences between metallic and insulating glasses, constitutes a major theoretical challenge. This challenge, however, is not directly addressed in what follows. Instead, the evidence for universal behavior and the theory which is necessary to understand this evidence are emphasized. It turns out that most of this evidence involves a comparison of phonon scattering in metallic glasses with its counterpart in insulating glasses.

57374 (ISM—217) **Current status of experimental tunneling results on niobium.** Bostock, J.; MacVicar, M.L.A.; Arnold, G.B.; Zasadzinski, J.; Wolf, E.L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Physics; Notre Dame Univ., IN (USA). Dept. of Physics; Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 7p. Dep. NTIS, PC A02/MF A01.

There has been a high level of interest in the electron-coupled-phonon spectrum (α^2F) of pure Nb especially since the discovery that nearly structurally perfect, single crystal Nb-substrate junctions with niobium oxide barriers formed either by in situ thermal oxidation or by acid etching techniques, yield anomalous value of λ and μ^*; i.e., λ is small ($\sim$ .6) and μ^* is negative ($\sim$ -.05). The recent calculation of Arnold et al., 1978 raises the question of the applicability of this proximity layer model to single crystal Nb-substrate tunneling data. This paper describes one such proximity analysis.

57375 (ISM—228) **Magnetic critical temperature gap in Gd-Y alloys.** Legvold, S.; Burgardt, P.; Beaudry, B.J. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 11p. (CONF-790909—8). Dep. NTIS, PC A02/MF A01.

From International conference on magnetism; Munich, F.R. Germany (Sep 1979).

In a search for Lifshitz points a very interesting and complex region in the magnetic phase diagram of Gd-Y alloys near 30 atomic percent Y was found. An apparent jump (gap) in the highest ordering temperature and perplexing magnetic behavior for samples near this expected Lifshitz point concentration was observed.

57376 **Computer simulation at high pressure.** Alder, B.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 51-63 of High pressure chemistry. Proceedings of the NATO advanced study institute held in Corfu, Greece, September 24 - October 8,

1977. Kelm, H. (ed.) (Frankfurt Univ. (Germany, F.R.)). Dordrecht, Netherlands; D. Reidel (1978).

The use of either the Monte Carlo or molecular dynamics method to generate equations-of-state data for various materials at high pressure is discussed. Particular emphasis is given to phase diagrams such as the generation of various types of critical lines for electronic transitions in solids, two phase ionic fluid systems of astrophysical interest as well as a brief aside of possible eutectic behavior in the interior of the earth. Then the application of the molecular dynamics method to predict transport coefficients and the neutron scattering function is discussed with a view as to what special features high pressure brings out. Lastly, an analysis by these computational methods of the measured intensity and frequency spectrum of depolarized light and also of the deviation of the dielectric measurements from the constancy of the Clausius-Mosotti function is given that leads to predictions of how the electronic structure of an atom distorts with pressure.

57377 Study of time-dependent spectral transfer in disordered systems. Lyo, S.K. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B: Condens. Matter;* **20**: No. 4, 1297-1305(15 Aug 1979).

We study the time development of spectral profile of an inhomogeneously broadened system of a low concentration of optically active random two-level impurity ions excited with a narrow-band laser pulse. The spectral transport is due to phonon-assisted spatial migration of optical excitations among the impurity ions. The basic two-site transfer rate is assumed to be site symmetric and independent of the energy levels of the initial and final sites when the thermal energy is much larger than the inhomogeneous width. A "direct transfer" model relevant to some current works is solved exactly for dipolar interaction at a low-impurity concentration. In this model transitions are allowed only between the initial site of excitation and rest of the ions. The result agrees well with a previous "exact" Monte Carlo calculation for a short time. The result is improved systematically for longer times by using a pair model, a three-site model, and a four-site model. In the first two models, energy transfer is allowed along one and two nearest-neighbor percolation bonds. respectively, starting from the initial site of excitation. In a four-site model additional transfer is included between the initial ion and its second neighbor. Transitions to the background ions without back transfer are allowed in all cases. Finally, the theoretical results are compared with recent experimental data.

57378 Method of differential areas for computing crystal symmetry independent density of states spectra. Budgor, A.B. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Comput. Phys.;* **32**: No. 2, 254-262(Aug 1979).

The differential area method for calculating joint density of states spectra given any electron or phonon dispersion relation is explained. Examples of this procedure are to nearest and next nearest neighbor phonon spectra in the harmonic approximation and to an electron network model of diatomic crystals. The advantages of this technique are that it is completely crystal symmetry independent, does not require any root searching of frequency or energy ranges, and can be utilized irrespective of the nature of the force model employed. Excluding initialization, the computer code in the MATHSY array language available at the Lawrence Livermore Laboratory is only 15 lines long.

57379 Direct methods of analyzing diffuse scattering. Georgopoulos, P.; Cohen, J.B. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *AIP (Am. Inst. Phys.) Conf. Proc.;* **53**: No. 1, 21-29(1 Jul 1979). (CONF-790341—).

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Methods of analysis of diffuse scattering have now reached the stage where thee are well tested and documented standard procedures for a variety of materials, and software, for both x-rays and neutrons. These methods and their meaning Are briefly reviewed.

57380 Modulated structures: 1979. Cowley, J.M.; Cohen, J.B.; Salamon, M.B.; Wuensch, B.J. (eds.). New York, NY; American Institute of Physics (1979). 444p. (CONF-790341—). Copyright Clearance Center, Inc., Box 765, Schenectady, NY 12301.

From International conference on modulated structures; Kailua-Kona, HI, USA (22 Mar 1979).

Separate abstracts were prepared for 23 papers within the subject scope of EDB.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 56914, 56915, 56916, 56926, 56942, 57012

57381 (INIS-mf—4820, pp 62-70) **Calculation of magnetic fields in systems with cryomagnetics.** Alievskii, B.L.; Bazhanov, A.A.; Orlov, V.L.; Sherstyuk, A.G. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Methods for calculating magnetic fields and parameters of systems with cryomagnetics are described. To obtain experimental characteristics, the magnetic properties of dysprosium in liquid nitrogen and helium at a field of $2x10^5$ A/m were measured. It is shown that for a sample of dysprosium distillate the magnetic characteristic at 77 K passes higher than the commercially pure dysprosium at 4.2 K. The experimental data are compared with the calculated ones. The experiment was conducted on models of axisymmetric magnetic systems containing ferromagnetic screens of steel or elements of dysprosium. The results of calculations and measurements of the magnetic flux through a circuit placed in the plane of symmetry of a solenoid are presented with the aim of studying the efficiency of cylindrical elements of commercially pure dysprosium. The estimates show that at the current of 200 A the induction increases to 3.1 T. It is concluded that cryomagnetics may be used very efficiently in systems with strong magnetic fields. The proposed calculation methods are applicable for screened unipolar electrical machines and also for solenoids of different designation.

57382 (INIS-mf—4820, pp 42-45) **Observations of training and degradation of current-carrying ability of short superconducting cables under mechanical load.** Anashkin, O.P.; Keilin, V.E.; Lykov, V.V. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The current-carrying ability of superconducting wires under the effect of a tensile mechanical load was investigated . Multistrand wires of the NT-50 material in a copper, german silver, and brass matrix were studied as well as wires of 0.5-1 mm diameter with 50% filling of the section with the superconductor, twisted and untwisted, and wires of the NT-50 material in a copper shell with an outside diameter of 0.33 mm. It is possible to create efforts up to 2000 N on a sample at a current of 500 A in it. A sample was placed in the superconducting solenoid transverse magnetic field up to 7 T. The 25% decrease in critical currents on increase in the loads on the sample to values corresponding to the rupture of the latter was detected. The voltage-current characteristics of samples except of single-strand and untwisted wires, showed voltage jumps corresponding to a short-term transition of the superconductor to the normal state. The possibility of reproducing phenomena occurring similarly to degradation and training phenomena in superconducting magnetic systems is demonstrated experimentally.

57383 (INIS-mf—4820, pp 50-54) **Calculation technique for complex optimization of a project of superconducting solenoid with a high magnetic field homogeneity.** Kabat, D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

A method for designing a superconducting solenoid with a high magnetic field homogeneity is proposed. The main coil and the sizes of the correcting coils were calculated. A solenoid version was chosen where the sections are wound with superconductors of different cross sections, are series connected and fed from one and the same current source. The winding consists of a three-section main coil and two correcting coils. On the basis of this procedure, a solenoid with a winding of wires with diameters of 0.7, 0.85, and 1.2 mm was developed and tested; the copper matrix of the solenoid contained 61 strands from the NT-50 alloy. At a critical solenoid current of 147.8 A, a magnetic induction 8.075 was achieved. A maximum inhomogeneity of not more than 1% on a 200mm portion of the solenoid axis and less than 1x10sup(-4) on a 60 mn portion was obtained.

57384 (INIS-mf—4820, pp 25-30) **Superconducting solenoid with two-phase helium cooling.** Keilin, V.E.; Kovalev, I.A.; Lelekhov, S.A. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The results of an investigation into superconducting magnet systems (SMS) with indirect cooling are presented. A model solenoid with a winding from Nb-Ti wire with an inner diameter of 42 mm, outer diameter of 102 mm, and a length of 120 mm was tested. The solenoid is wound on a copper form and compounded. Tubes for coolant circulation are brazed to the carcass lugs. A simple and

economical system of SMS cooling with the use of the vapour lift of two-phase helium is proposed. A maximum current of 140 A was achieved in SMS testing, which is 3% below the current for loaded SMS. The fundamental possibility of estimating the losses in introducing and extracting the energy in indirectly cooled SMS by the change in their temperature was discovered. The expressions for determining the time of cooling of the system to the operating temperature and the temperature distribution over the winding for different SMS were obtained.

57385 (INIS-mf—4820, pp 46-49) **Diamagnetic forces in superconducting magnetic systems.** Keilin, V.E. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The strength manifestation of diamagnetic effects in superconducting magnetic systems (SMS) was estimated with the aim of studying the expedience of utilization of SMS based on buses with parallel superconductors. A model of a flat bifilar bus in an external magnetic field is considered. It is shown that the manifestation of diamagnetic forces becomes more real at the system edge or in the gaps between the coils, which may cause a premature transition of SMS to the normal state. A method for weakening the diamagnetic effects by using additional windings or ferromagnetic guides with the aim of reducing the radial component of the magnetic field is proposed.

57386 (INIS-mf—4820, pp 71-81) **Study on magnetic field distribution in superconducting magnetic systems with account of magnetization of a superconducting winding.** Shakhtarin, V.N.; Koshurnikov, E.K. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

A method for investigating a magnetic field in a superconducting magnetic system with an allowance for magnetization of the superconducting winding material is described. To find the field, use was made of the network method for solving a nonlinear differential equation for the scalar magnetic potential of the magnetization field with adjustment of the boundary conditions by the boundary relaxation method. It was assumed that the solenoid did not pass into the normal state, and there were no flow jumps. The calculated dependences for the magnetization field of a superconducting solenoid with an inner diameter of 43 mm, an outer diameter of 138 mm, and a winding of 159 mm length are presented. The solenoid is wound with a 37-strand niobium-titanium wire. The magnetization field gradient in the area of the geometrical centre with a magnetic field strength of 43 kOe was equal to 1 Oe/cm, this meaning that within a sphere of 1 cm radius the inhomogeneity of the magnetization field was 2.5×10^{-5}.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 57302

57387 **Position-momentum uncertainty products for exactly solvable potentials.** Nieto, M.M. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **20**: No. 3, 700-705(Sep 1979).

The author shows how the position-momentum uncertainty products may be obtained analytically for the eigenstates of the exactly solvable symmetric Poeschl-Teller, symmetric Rosen-Morse, and one-dimensional Morse potentials.

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 57388

ELECTRICITY AND MAGNETISM

REFER ALSO TO CITATION(S) 57421

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 57269

COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY

57388 (LASL—78-91) **Einstein and general relativity: historical perspectives.** Chandrasekhar, S. (Los Alamos Scientific Lab., NM (USA)). 17 Aug 1978. 23p. Los Alamos Scientific Lab., Los Alamos, NM.

The place of Einstein in 20th-century physics is discussed. The basic ideas that led Einstein to his theory of gravitation by the sheer power of speculative thought are described in the most general terms. The prediction of the bending of starlight by the Sun and the eclipse expedition of 1919 are recounted. The author feels that "the general theory of relativity is incredibly rich in its content;...one finds a glittering face at almost every turn." The prediction of black holes by general relativity is noted. (RWR)

FUSION ENERGY

REFER ALSO TO CITATION(S) 57245, 57246, 57247, 57249

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

57389 (CEA-CONF—4259) **Lower hybrid experiments in the Petula tokamak.** Singh, C.M.; Briand, P.; Dupas, I. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1978. 4p. (CONF-780113—9). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. conference on RF plasma heating; Pasadena, CA, USA (11 Jan 1978).

The study of lower hybrid waves on Petula Tokamak addresses itself to the following questions: wave excitation by phased waveguide arrays, technological problems encountered with high power microwave circuitry, and nonlinear processes induced by large amplitude pump waves. An r.f. generator was used to deliver a maximum power of 1.0 MW, 100 μs at 1.25 GHz to a two waveguide grill (Emax=4 kV/cm). The data reported here were taken in a deuterium plasma, $n(e)=3.5 \times 10^{13} cm^{-3}$, T(e) 500 eV, T(i) 200 eV and B=15 kG. The choice of the plasma parameters and the frequency of the pump was made so as to avoid the linear mode conversion layer in the plasma.

57390 (DOE/ET—0112, pp 12p, Paper 2) **Direct ion heating in EBT confinement.** Ard, W.B.; Kashuba, R.J. (McDonnell Douglas Research Labs., St. Louis, MO). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Direct heating of the ions appears to be the most feasible experimental approach for investigating the properties of transport in EBT configuration Ion heating will in principle allow control over the ambipolar potentials which play such an important role in neoclassical transport. However, the effects of ion heating on the ion distribution function will have to be carefully considered in designing the experiment and interpreting the results. To the extent that ion heating can be substituted for ECRH heating of the bulk toroidal plasma certain aspects of the physics of the hot-electron annulus may be investigated independently of the toroidal plasma. These annulus properties include power balance in the hot electrons and density requirements for annulus stability.

57391 (DOE/ET—0112, pp 23p, Paper 6) **Ambipolar diffusion in the ELMO Bumpy Torus.** Guest, G.E. (General Atomic Co., San Diego, CA). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

In the ELMO Bumpy Torus experiment, EBT-I, developed by R.A. Dandl at the Oak Ridge National Laboratory, a quiescent regime of operation called the T mode exhibits plasma parameters which agree at least qualitatively with the neoclassical transport theory first discussed by Kovrizhnykh. In particular, the electron energy confinement time appears to increase with electron temperature roughly as T/sub e//sup 3/2/, as predicted for the collisionless limit of neoclassical confinement. However, attempts to make more detailed, quantitative comparisons between neoclassical theory and empirical results have encountered persistent difficulties in finding stable operating regimes which reproduce the experimental parameters. Here we shall identify a fundamental physical process, not accounted for by the conventional transport models, which seems likely to play a dominant role in ion confinement in EBT-I, where plasma ions are created continuously, in steady state, at low initial energies.

57392 **Stability effects of external conducting sheets on magnetically contained plasmas.** Weston, V.H. (Purdue University, West Lafayette, Indiana 47907). *Phys. Fluids;* **22**: No. 10, 1944-1951(Oct 1979).

A comparison of the effect of different configurations of the outer conducting surface on the stability of a cylindrical circular plasma of radius a and length L is made. As opposed to the usual

configuration of a concentric circular outer conductor, "fins" or radial conducting surfaces lying on the field lines with the nearest edge a distance c from the center of the plasma are considered. The comparison procedure is based upon estimating the difference of the perturbed energy integrals for the various configurations. The usual surface perturbations of the form exp[i (kz +- nθ)], k~0 are treated. Fins of zero thickness have no effect on the n = 0 mode; however, they do tend to stabilize the important n = 1 mode. For a/c sufficiently small, radial planes θ = 0, π, and +- π/2 tend to have the same stabilization effect on the n = 1 mode as a concentric outer cylinder of radius b, where b~√2c. The interaction between the opposite fins was taken into account.

57393 Energy- and particle-confinement properties of an end-plugged, linear, theta pinch. Commisso, R.J.; Bartsch, R.R.; Ekdahl, C.A.; McKenna, K.F.; Siemon, R.E. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 6, 442-445(6 Aug 1979).

Experiments show that axial confinement of plasma in a straight theta-pinch solenoid is improved by placing solid lithium deuteride plugs at the ends. The energy confinement is increased nearly threefold in agreement with theoretical estimates which assume classical electron thermal conduction and no convective losses. The confinement of deuterium ions is explained by classical Coulomb collisions in the ablated lithium deuteride plasma.

57394 Adiabatic magnetic compression of field-reversing E layers. Tuszewski, M.; Rej, D.J.; Fleischmann, H.H. (School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **43**: No. 6, 449-452(6 Aug 1979).

In the RECE-Christa device, electron rings were adiabatically compressed in low-density background gas with axial magnetic field compression ratios B/sub z/f/B/sub z/i < or ≈ 4, without encountering any gross instabilities or other anomalous losses. In agreement with a simplified theoretical model, the field-reversal factor, δ, remains constant, and the major radius and the axial length of the rings scale with B/sub z/ /sup -1/2/ while the ring current increases with B/sub z/ /sup 1/2/. Furthermore, field-reversal times have been extended to 1.1 msec.

57395 Numerical determination of axisymmetric toroidal magnetohydrodynamic equilibria. Johnson, J.L.; Dalhed, H.E.; Greene, J.M.; Grimm, R.C.; Hsieh, Y.Y.; Jardin, S.C.; Manickam, J.; Okabayashi, M.; Storer, R.G.; Todd, A.M.M.; Voss, D.E.; Weimer, K.E. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *J. Comput. Phys.;* **32**: No. 2, 212-234(Aug 1979).

Numerical schemes for the determination of stationary axisymmetric toroidal equilibria appropriate for modeling real experimental devices are given. Iterative schemes are used to solve the elliptic nonlinear partial differential equation for the poloidal flux function psi. The principal emphasis is on solving the free boundary (plasma-vacuum interface) equilibrium problem where external current-carrying toroidal coils support the plasma column, but fixed boundary (e.g., conducting shell) cases are also included. The toroidal current distribution is given by specifying the pressure and either the poloidal current or the safety factor profiles as functions of psi. Examples of the application of the codes to tokamak design at PPPL are given.

57396 Low-Zsub(eff) plasma confinement in TFR 600 tokamak. pp 135-144 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

TFR 600 is a tokamak which has mainly been devoted so far to one goal: the study of stable discharges at high plasma densities average value of n approximately $>7x10^{13}cm^{-3}$ for Isub(p)=200kA, Bsub(T)=40kG. In this case, Zsub(eff) is close to one, the ions contribute to the energy balance and seem to behave non-neoclassically. By polluting the vacuum chamber, it has been possible to reproduce TRF-400-type discharges, dominated by the electrons and impurity ions (Zsub(eff) approximately 5). The MHD activity investigated is characterized by a high-level m=3 tearing mode and by the evidence of a minor disruption during the overlap of m=3, m=2 modes.

57397 Studies on Ohmic heating in T-10. Bagdasarov, A.A.; Berlizov, A.B.; Vasin, N.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 35-49 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Plasma confinement was studied in T-10 with Ohmic heating for a safety factor q(a)<3. The electron and ion temperature radial profiles were obtained. Up to 70% of the power introduced was lost by radiation. The discharge parameters did not change radically for different limiter materials. The average effective plasma charge average value of Zsub(eff) was 1.2-1.5. The discharge chamber wall, and not the limiter, was the main source of incoming impurities. A flattening of the electron temperature profile was detected after an m=1 internal disruption had occurred. A hollow Tsub(e)(r) profile was observed before the disruption, with a simultaneous break-off of the sawtooth oscillations. The existence of anomalous electron heat losses and classical ion losses became evident from a comparison of experimental data with computer simulations.

57398 Experiments on Ohmic heating and compression of a plasma in the Tuman-2A tokamak. Berezovskii, E.L.; Vil'dzhyunas, M.I.; Gladushchak, V.I. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). pp 349-362 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Experiments performed in the small tokamak Tuman-2A and intended for a study of magnetic compression are described and the first experimental results are presented. A discharge which was marginally stable against disruptions with central parameters of Tsub(e)(0)=450eV and nsub(e)(0)=$3x10^{13}cm^{-3}$ was studied. Two-fold compression during o.5ms followed by a crow-bar period was used in these experiments. For the post-compression stage the transport coefficients have been found to be approximately twice as small, whereas radiation losses from the hot core have increased.

57399 Equilibrium configurations and heating in compact ignition experiments. Coppi, B. (Massachusetts Inst. of Tech., Cambridge (USA)); Taroni, A.; Cenacchi, G. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). pp 487-505 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

A compact toroidal experiment with the aim of achieving the ideal ignition temperature in D-T plasmas, while ntausub(E) exceeds $10^{14}scm^{-3}$, is studied. The reference design parameters are a poloidal field of 30kG and a peak plasma current density of $5kAcm^{-2}$, for appropriate values of the relevant safety factors. The expected heating cycles were examined by a one-dimensional transport code including collisional and anomalous transport coefficients that can reproduce the results of existing experiments and anticipate the effects of trapped electron instabilities. It is noticed that the α-particle heating tends to produce a thermal instability around the centre of the plasma column and that the expected presence of collective modes can influence the reacting part of the ion distribution and increase the rate of fusion reactions. An analysis of the equilibrium configuration on the basis of the ideal MHD approximation has led to the identification of an optimal cross-section for the plasma column and the associated distribution of the equilibrium field and air-core transformer coils. The basic characteristics of the mechanical structures for the toroidal magnet and the air-core transformer systems are described and a numerical analysis of the relevant stress distribution, including the effects of temperature excursion, developed. A phase of adiabatic compression is included mainly to provide (a) a form of control of the temperature and density profiles influencing the obtainable heating cycles, and (b) the opening of a considerable access area without affecting the confinement of the α-particle produced in the compressed stage.

57400 Modelling of discharge dynamics in tokamaks. Dnestrovskii, Yu.N.; Lysenko, S.E.; Pereverzev, G.V.; Tarasyan, K.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Kostomarov, D.P. (M.V. Lomonosov State University, Moscow, USSR). pp 443-454 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Calculations are made of the plasma energy and particle balance during the ionization and current rise stage in the T-10 tokamak and also of the plasma heating dynamics in T-11 during neutral-beam injection.

57401 PLT neutral beam heating results. Eubank, H.; Goldston, R.J.; Arunasalam, V. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 167-197 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Experimental results from high-power neutral beam injection experiments on the PLT (Princeton Large Torus) tokamak are reported. At the highest beam powers (2.1MW) and lowest plasma densities [nsub(e)(0)=$4.5x10^{13}cm^{-3}$], ion temperatures of 5.5keV are achieved. The ion collisionality nusub(i)sup(*) drops below 0.1 over much of the radial profile. Electron heating of ΔTsub(e)/Tsub(e)

approximately 50% has also been observed, consistent with the gross energy confinement time of the Ohmically heated plasma, but indicative of enhanced electron energy confinement in the core of the plasma.

57402 Plasma heating near lower-hybrid frequency in JFT-2 tokamak. Fujii, T.; Fujisawa, N.; Funahashi, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 85-95 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

An experimental investigation of lower hybrid heating at frequencies of 650 and 750MHz is reported. An RF coupling efficiency of about 90% is obtained up to the a power level of 140kW by using an array of four waveguides. Effective ion heating (ΔTsub(i perpendicular)/Tsub(i)=50-60% by charge exchange and 25-30% by spectroscopy) has been obtained on the application of 135kW when the turning point is near the plasma centre. The temperature increase is also seen to be proportional to the input RF power. Apparently hot ions are not always localized in the plasma periphery. Even in the case of high density and high power (ω_{0i}/ωsub(LH)=0.8, net Psub(RF)=80-100kW), fairly effective ion heating is observed, which may suggest that some non-linear mechanisms in the plasma heating are of crucial importance.

57403 Investigation of lower-hybrid plasma heating in FT-1 tokamak. Golant, V.E.; Gusev, V.K.; D'yachenko, V.V. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). pp 113-119 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Physical phenomena related to lower hybrid plasma heating are studied at Tokamak FT-1. The lower hybrid waves were excited by a passive slowing-down structure. In a "cold"-plasma regime (Tsub(e) approximately 10eV) the propagation of the waves in a toroidal geometry was investigated by movable probes. It was found that the HF fields were localized inside a resonance cone calculated for experimental conditions. Spectra of oscillation and probe signals on HF power were measured in the central and peripheral regions of the discharge. The power dependence of the signals was found to be non-linear. In a "hot"-plasma regime (Tsub(e) approximately 300eV) the changes in the plasma parameters were studied under a 400-MHz HF pulse with powers up to 60kW and durations up to 1ms. The power absorption by ions with an efficiency of 15% was observed by a neutral-particle analyser. The increase in electron temperature was recorded by laser diagnostics in the vicinity of the LHR regions. The electron temperature profile was observed to broaden, and the toal energy containment in the plasma increased during the HF pulse.

57404 Study of the energy balance in Alcator. Gondhalekar, A.; Granetz, R.; Gwinn, D. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). pp 199-209 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Stable discharges with average density anti nsub(e)=7.5×10^{14}cm^{-3} have been obtained in deuterium at Bsub(T)=8.7T in the Alcator tokamak. Complete thermal equilibration between electrons and ions obtains, with peak temperatures of 900eV. The maximum value of ntausub(E) is 3×10^{13}cm^{-3}s. Nearly classical behaviour, from the viewpoint of energy confinement, is observed. A study of the energy balance of the central core of the plasma has been carried out in the regime 10^{14}cm^{-3} <= anti nsub(e) <= 6×10^{14}cm^{-3}, 130kA <= Isub(p) <= 160kA and Bsub(T)=6T. At the highest densities, the dominant role in energy confinement can be attributed to ion thermal conduction. Stable operation of high-current, low-qsub(L) discharges has been achieved. The strong MHD activity can be controlled by proper programming of plasma current and density. Some improvement in overall energy confinement is observed for the low-qsub(L) discharges. A study has been made of low-frequency electron density fluctuations using an infra-red laser. Small-angle scattering and crossed-beam correlation techniques were used. The most striking feature of the results is the observation that for anti nsub(e) > 10^{14}cm^{-3} the amplitude of density fluctuations, n tildesub(e), peaks at the minor radius corresponding to that of the limiter. At the peak 0.2 <= n tildesub(e)/nsub(e) <= 1.

57405 Scaling law for the plasma energy life-time in tokamaks. Mirnov, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 433-441 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

It is suggested that a channel related to anomalous electron energy transport due to macroscopic MDH m=3 and m=2 kink modes should be separated from the total energy balance of a tokamak plasma. "Stable" and "unstable" regimes are distinguished, and the "stable" regimes are found to be well described by a T-3 scaling law.

57406 Lower-hybrid heating in the Wega tokamak. Pacher, H.D. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Blanc, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service Ionique Generale); Durvaux, M. (Ecole Royale Militaire, Brussels (Belgium)). pp 97-111 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

In the Wega experiment, 125kW of HF power at 500MHz are applied for 10ms. The ion energy increases by a factor of 2.5; the electron energy doubles. The ion temperature increase is demonstrated to be thermalized by the agreement between the perpendicular and parallel charge-exchange measurements and Doppler broadening of the OVII line. About 15kW of HF power are absorbed by the ions and, once inductive effects have been taken into account, about 30kW of HF power are tentatively deduced to be absorbed by the electrons. This is to be compared with 60kW of HF power estimated to be able to penetrate into the central region of the plasma using the non-optimized coupling structures of the present experiment.

57407 Plasma heating and stability in T-11 tokamak with neutral-beam injection. Vlasenkov, V.S.; Leonov, V.M.; Lohr, J.; Merezhkin, V.G.; Mukhovatov, V.S.; Sannikov, V.V.; Tilinin, G.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 211-229 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Plasma stability and confinement in low-q-value discharges (q(asub(L)) approximately equal to 2.1-2.8) with Ohmic heating alone and during neutral-beam injection were investigated in the T-11 tokamak in a wide density range, anti nsub(e)=$(0.8\text{-}7)\times10^{13}$cm^{-3} at Zsub(eff) approximately equal to 1. The gross energy confinement time tausub(E) in Ohmically heated discharges at q(asub(L)) approximately equal to 2.5 was found to be a nearly linear function of anti nsub(e). At anti nsub(e) approximately equal to $(4\text{-}6)\times10^{13}$cm^{-3} and a plasma current of 100-120kA, a value of tausub(E) approximately equal to 6-8ms was obtained, which is only twice as small as that calculated by using neoclassical thermal conductivity. In experiments with beam injection into a low-density plasma (anti nsub(e) approximately equal to 1.4×10^{13}cm^{-3}), the ion temperature was increased by a factor of 2.5 (from 150 to 400eV), and a "collisionless regime" was obtained both for ions and electrons with a minimum value of the collisionality factor, nusup(*) approximately 0.2. When the beam was injected into a high density plasma (anti nsub(e) approximately equal to 4.5×10^{13}cm^{-3}), the following values were obtained: βsub(p) approximately equal to 0.85; average value of βsub(T) approximately equal to 1% and βsub(T)(0) approximately equal to 4%. In both cases, significant electron heating was observed. The electron energy confinement was found to improve with increased density as well as with Ohmic heating alone.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 57511

57408 (COO—4021-3) **Development of a high resolution, cylindrical crystal spectrometer for diagnostics of x rays emitted from hot plasmas. Progress report, August 1, 1978-October 31, 1979.** Taylor, P.O.; Schnopper, H. (Smithsonian Astrophysical Observatory, Cambridge, MA (USA)). Jul 1979. Contract EY-76-S-02-4021. 22p. Dep. NTIS, PC A02/MF A01.

Progress towards development of a high resolution, high throughput, curved crystal spectrometer suitable for line shape diagnostics of x rays emitted from hot plasmas is outlined. The instrument has been interfaced with the MIT Tokamak (Alcator) with the initial aim of studying the prominent MoL and ClK lines which occur in the x-ray spectrum. However, it will have the versatility to function over an energy range of at least 1.5 keV to 7 keV allowing determination of temperature, charge state and density distributions for important ions. Using a large PET crystal, spectra from a Mo target x-ray tube have been obtained over an energy range of 2.3 to 2.6 keV and showing line widths of 2 to 5 eV, consistent with natural broadening. The use of mosaic crystals to improve the sensitivity-resolving power product of the spectrometer by over an order of magnitude is being studied.

57409 (PPPL—1582) **Study of the mass and energy resolution of the E parallel B charge exchange analyzer for TFTR.** Kaita, R. ; Medley, S.S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Sep 1979. Contract EY-76-C-02-3073. 34p. Dep. NTIS, PC A03/MF A01.

The charge exchange diagnostic for TFTR requires simultaneous multispecie (H^+, D^+, γ^+) analysis of particles in the energy range of 0.5 - 150 keV. The analyzer design chosen to provide this capability employs a wide gap semi-circular region of superimposed parallel electric and magnetic fields to accomplish mass and energy resolution, respectively. Combined with a large area, multi-anode microchannel plate detector, this arrangement will enable the energy distributions of protons, deuterions, and tritons to be measured concurrently as a function of time during each discharge. A computer simulation program for calculating ion trajectories through the analyzer was written that includes a realistic model of the magnetic and electrostatic fringe fields. This report presents the results of a study of the proposed E parallel B analyzer, and it reveals that the fringe fields are not detrimental to the performance of the analyzer.

PLASMA KINETICS - GENERAL

57410 (PPPL—1577) **Conditions for soft x-ray lasing action in a confined plasma column.** Suckewer, S.; Fishman, H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Sep 1979. Contract EY-76-C-02-3073. 46p. Dep. NTIS, PC A03/MF A01.

The idea of using a multi-Z (e.g., carbon, oxygen) thin plasma column as a medium for soft x-ray lasing action is presented. A plasma confined by a strong magnetic field is first heated by a CO_2-laser, and then cools rapidly by radiation losses. This leads to a level population inversion of hydrogen-like carbon or oxygen ions. Two computational models are presented. One uses given electron temperature, T/sub e/(t), evolutions. The other uses T/sub e/(t) calculated from an energy balance equation ith CO_2-laser beam power as a parameter. According to calculations, a total gain of $G > 100$ is expected for $3 \rightarrow 2$ and $G > 10$ for $4 \rightarrow 2$ transitions ($\lambda = 182$ A and $\lambda = 135$ A, respectively) for CVI ions using a CO_2-laser beam with power $\sim 5 \times 10^{10}$ W for plasma column heating.

57411 **Investigation of modulated runaway losses and effects of a helical dipole field in Pulsator.** Fussmann, G.; Engelhardt, W.; Feneberg, W.; Gernhardt, J.; Glock, E.; Karger, F.; Sesnic, S.; Zehrfeld, H.P. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). pp 401-411 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The hard X-ray emission from the limiter of Pulsator tokamak shows three distinct types of intensity modulations: an oscillation correlated with the m=2 mode, strong sawtooth modulations coincident with the internal disruptions, and radiation bursts indicating an external disruption or a similar type of instability. For the purpose of interpretation, the trajectories of runaways in the presence of helical magnetic perturbations are calculated. From these calculations the m=2 oscillations in the hard X-rays can be explained. Moreover, it is found that, in case of strong magnetic ergodization, the runaways may travel large radial distances, but are still confined within the plasma. Finally, experiments with a partial m=1, n=1 winding on Pulsator are briefly reported. By means of this helical field the m=2 mode can be suppressed. External disruptions can also be thus triggered. Suppression of internal disruptions by the dipole part of the field is observed only at low densities.

PLASMA KINETICS - EXPERIMENTAL

REFER ALSO TO CITATION(S) 57253

57412 (CONF-790867—1) **Control of impurities in controlled fusion machines.** Gruen, D.M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From 4. international symposium on plasma chemistry; Zurich, Switzerland (27 Aug 1979).

Recent advances in Tokamak research have given promise that the next generation of machines may approach break even conditions. Nonetheless, calculations show that quasi-steady state fusion reactors may be plagued by high Z impurities causing intolerable radiation losses. The present state of knowledge concerning impurity release rates and mechanisms resulting from plasma-materials interactions as well as impurity transport and detection diagnostics, is reviewed. Various impurity control methods are discussed which either are being currently used or have been proposed and are in the development stage. The paper attempts to convey to the non-specialist an impression of the magnitude and importance of the impurity control problem and points to areas where plasma chemical insights can aid in the development of better approaches to impurity control.

57413 (DOE/ET—0112, pp 37p, Paper 5) **Spatial distribution of impurities and H neutrals in ELMO Bumpy Torus (EBT).** Lazar, N.H. (Oak Ridge National Lab., TN); Carpenter, K.H.; Tyson, J.M.; Warden, E.S.; Moos, H.W. Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Absolute brightness measurements and spatial scans in the vacuum ultraviolet have been used to investigate the presence and spatial density distribution of various charge states of carbon and aluminum (the major impurities) and neutral hydrogen in the ELMO Bumpy Torus. The impurity concentrations are quite low; the total fractional carbon concentration in the toroidal core (compared to the electron density) is less than 6×10^{-5}. Sources for the C and Al impurities are examined. Experimental evidence and arguments based on the space potential and drift surfaces which are presented indicate that the surface blanket plasma plays a role analogous to a divertor, shielding the core plasma from impurities.

57414 **Preliminary results on the FT tokamak.** Ascoli-Bartoli, U.; Bardotti, G.; Bartiromo, R. (Associazione Euratom-CNEN sulla Fusione, Centro di Frascati, Rome, Italy). pp 149-156 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The Frascati Tokamak (FT) has been operated at a toroidal field up to 80kG and 600kA of plasma current. The electron energy replacement time increases linearly with density. A total energy containment time of 25ms has been reached at a peak density of $3 \times 10^{14} cm^{-3}$.

57415 **Deuterium diffusion studies in a tokamak plasma by pulsed injection.** Buzankin, V.V.; Vershkov, V.A.; Dnestrovskii, Yu.N.; Izvozchikov, A.B.; Mikhajlov, E.A.; Pereverzev, G.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 287-296 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The space and time evolution of the injected deuterium density in a helium tokamak plasma is investigated. The experiments were carried out in the Tokamak-4 device in the following regime: Hsub(z)=30kOe, I=90kA and average value of nsub(e)=$2 \times 10^{13} cm^{-3}$. The deuterium density was determined by analysis of fast neutral deuterium atoms undergoing charge exchange in a hydrogen beam. The deuteron confinement time in the central column zone of 20-25ms, measured in this manner, is close to the previously measured life-time of argon of 30-35ms. Conclusions are made in the paper on the absence of a strong dependence of particle life-time on charge. It is shown that the confinement time increases as the discharge current increases and does not depend on electron density.

57416 **Accumulation of impurities and stability behaviour in the high-density regime of Pulsator.** Engelhardt, W.; Klueber, O.; Meisel, D. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). pp 123-133 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

At the end of high-density plateaus, a strong accumulation of impurities by a factor of 5 within less than 10ms is observed. This leads to a displacement of the current into an outer region with a subsequent steepening of the gradient at the q=2 surface. The resulting disruption prevents the production of longer density plateaus. From observations of the internal disruption and of the m=2, n=1 mode activity we have further evidence that steep current gradients at q=2 trigger the current disruption. The existence of a sharp density limit, however, cannot be explained satisfactorily in these terms. - High densities up to $10^{14} cm^{-3}$ can be obtained in high-current discharges with q=2.1. The energy confinement time scales proportionally to nsub(e) with little or no dependence on the total current. The transport by internal disruptions is enhanced in these low-q discharges.

57417 **Distribution of plasma and impurity fluxes on the walls of the DITE tokamak.** McCracken, G.M.; Goodall, D.H.J. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.); Bridwell, L.B.; Dearnaley, G.; Shea, J.H.; Sofield, C.J.; Turner, J. (UKAEA, Harwell. Atomic Energy Research Establishment). pp 297-302 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Measurements are described of the spatial distribution of impurities deposited on the walls of the DITE tokamak. Layers have

built up of approximately 0.1-1.0μm thickness which contain Fe, Cr, Ni, Mo, O, C and H. Detailed depth profiles of hydrogen implanted in the solid have been obtained and concentrations of approximately 10 at.% over 0.1μm are typical. The oxygen and carbon concentrations are approximately 1-5 at.% and 5-10 at.% respectively. Much higher concentrations of O and H have been detected on areas of the torus on which titanium has been evaporated. The effect of these deposits on the tritium inventory of machines operating in DT is discussed.

57418 **Spectroscopic measurements of highly ionized impurity ion concentrations and their diffusion in the DITE tokamak.** Peacock, N.J.; Hughes, M.H.; Hobby, M.; Fielding, S.J. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.); Summers, H.P. (Cambridge Univ. (UK)); Mansfield, M.W.D. (Imperial Coll. of Science and Technology, London (UK)). pp 303-314 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The highly ionized impurity ion species within the DITE plasma are described. Grating dispersion spectroscopy is used to measure their spatial concentration under a variety of operating conditions. When no attempt is made to reduce the impurity level by gettering, divertor action or by pulsing in gas during the current flow, the core of the plasma is radiation-dominated due to metallic impurities. These ions can be substantially reduced in concentration by the bundle divertor. Spatial variation of the dominant oxygen ions is reasonably accounted for using a time-dependent neoclassical ion diffusion model. From a simple spatial measurement of the ratios of line intensities in He-like ions the electron temperature and non-equilibrium ion abundances are deduced, and from these the diffusion velocity of ions (e.g. O^{6+}) can be independently derived. Finally, line profile scans of the oxygen ion emission provide evidence for an ion energy component approximately 5keV, during hydrogen beam injection.

57419 **Investigation of plasma X-ray emission in the T-10 tokamak.** Vinogradova, N.D.; Esipchuk, Yu.V.; Kovrov, P.E.; Razumova, K.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Szentpetery, I.; Hrehuss, G.; Kardon, B.; Hordosy, G. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). pp 257-266 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The emission of T-10 plasma at energies between 200eV and 35keV is recorded by using various X-ray detectors. Investigations are made of the shape of the electron energy distribution function, its variation over the plasma radius and the behaviour of the plasma impurity composition and its effective charge during the discharge.

PLASMA KINETICS - THEORETICAL

57420 (COO—3004-27) **Investigation in plasma dynamics. Annual progress report, December 15, 1978-September 15, 1979.** Schmidt, G. (Stevens Inst. of Tech., Hoboken, NJ (USA)). Jul 1979. Contract EY-76-S-02-3004. 6p. Dep. NTIS, PC A02/MF A01.

A summary of work completed during this period is given. Plasma expansion as a result of heating, particle injection, and alpha particle generation is discussed. The transient growth of shear Alfven waves in current carrying infinitely conducting plasma is also mentioned. (MOW)

57421 (COO—3004-29) **Momentum transfer from waves to particles.** Schmidt, G. (Stevens Inst. of Tech., Hoboken, NJ (USA). Dept. of Physics and Engineering Physics). May 1979. Contract EY-76-S-02-3004. 9p. Dep. NTIS, PC A02/MF A01.

Momentum transfer from an electromagnetic or electrostatic wave to an electron is calculated in the presence of friction, and is shown to be comparable to the one obtained from the ponderomotive force. Radiation reaction is analyzed as a special case and shown to be derivable from the classical limit of Compton scattering.

57422 (DOE/ET—0112) **Proceedings of the EBT transport workshop.** (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Aug 1979. 398p. (CONF-7905112—). Dep. NTIS, PC A17/MF A01.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Separate abstracts were prepared for 14 of the included papers. A title list is given for the remaining papers. (MOW)

57423 (DOE/ET—0112, pp 28p, Paper 3) **Neoclassical interpretation of EBT.** Hedrick, C.L. (Oak Ridge National Lab., TN). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

A poster session is given for the following concepts: (1) EBT scaling, (2) guiding center orbits in EBT, and (3) key experimental results which motivate the theory interwoven. (MOW)

57424 (DOE/ET—0112, pp 28p, Paper 4) **Plasma simulation of the EBT using Kovrizhnykh neoclassical transport.** Krakowski, R.A.; Hagenson, R.L. (Los Alamos Scientific Lab., NM). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

The point model described herein serves as the primary computational tool by which self-consistent EBTR operating point(s) are studied. Time-dependent transport results for reactor-grade plasmas are presented. These results will be re-examined in the near future, when parallel studies of the energetics of the hot-electron rings and more detailed calculations of EBT magnetics, including the aspect-ratio-enhancement (ARE) coils, have shown sufficient progress.

57425 (DOE/ET—0112, pp 21p, Paper 7) **Kinetic transport in EBT with ambipolar fields.** Spong, D.A. (Oak Ridge National Lab., TN). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Neoclassical transport occurs in the EBT device as collisions randomly move particles from one drift surface to another. As a result of the toroidal curvature drift, these drift surfaces are displaced off-center in the torus with the displacement depending on the particles energy and magnetic moment. A certain fraction of the drift surfaces will be crescent-shaped, i.e., blocked in their poloidal motion. The theory for these processes is described.

57426 (DOE/ET—0112, pp 34p, Paper 8) **Radial transport theory in EBT.** Jaeger, E.F.; Hedrick, C.L.; Spong, D.A. Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

The theory is described for the following three cases: (1) ambipolar field calculations, (2) collisional transport results, and (3) collisionless transport results. (MOW)

57427 (DOE/ET—0112, pp 26p, Paper 9) **Two dimensional transport model of EBT.** Klein, H.H.; Byrne, R.N. (Science Applications, Inc., La Jolla, CA). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Transport coefficients were described and incorporated into the 1D transport equations, and a number of runs were performed to determine if the experimental results could be reproduced. There are indications that in the experiment for sufficiently low collisionality the electron temperature multiplied by the confinement time, T/sub e/tau/sub e/, increases as the collisionality is reduced. In the 1D runs as the collisionality was reduced, stable steady state operated with negative ambipolar fields was observed. The peak electron and ion temperatures were on the order of 300 and 100 eV respectively, and the central electron density was approximately 2.5×10^{12} cm^{-3} with a corresponding value of $\nu/\Omega \approx 0.5$.

57428 (DOE/ET—0112, pp 18p, Paper 10) **Collisionless limit of bumpy torus transport.** Catto, P.J.; Rosenbluth, M.N. (Science Applications, Inc., La Jolla, CA). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

The two models investigated to date are discussed. The first model is the axisymmetric Bumpyless Torus (BLT) which might be valid in the electron ring region if most of the ions are untrapped. Next a Bumpy Torus model is considered in which Ω is evaluated neglecting toroidal effects and V is obtained by assuming B proportional to 1/R (with $R = R_0 + r\cos\beta$) due to the toroidal field coils. The quantity R_0 is the distance from the axis of the torus to the magnetic axis. In this second model the $\Omega = 0$ ions are those that are mirror trapped. The transport of the untrapped ions is smaller by ε/ sup 3/2/. In addition, the dominant electron transport is assumed to be due to the trapped electrons.

57429 (DOE/ET—0112, pp 14p, Paper 11) **Banana orbit diffusion in EBT.** Tsang, K.T. (Oak Ridge National Lab., TN). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

Confined banana orbits are discussed, where the spatial (radial) dependence of Ω is not weak. Like the bananas in tokamaks, the bananas in EBT also contribute significantly to neoclassical transport in the low collision frequency regime. The similarities and differences between tokamaks and EBT in this respect are described.

57430 (DOE/ET—0112, pp 12p, Paper 12) **Computational evaluation of drift orbits and transport in EBT.** Boozer, A.H.; Kuopetravic, L.G. Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

A theory is given that attempts to find excursions of particle drift orbits from constant pressure surfaces, and also numerically evaluates transport coefficients in a Monte Carlo sense. (MOW)

57431 (DOE/ET—0112, pp 13p, Paper 13) **Alternating dimension 3D equilibrium and transport algorithms for EBT.** Grad, H. (New York Univ., NY). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

A formulation for a 3D scalar pressure macroscopic transport code (scalar or tensor resistivity and heat conductivity) has been described earlier; a code of this kind is presently being developed (jointly at NRL and NYU). The fully 3D macroscopic transport (and adiabatic) model for EBT is formulated in a numerically efficient, Alternating Dimension (AD formerly 1-1/2 D) version. This note contains highlights of this formulation (also some new information).

57432 (DOE/ET—0112, pp 17p, Paper 14) **Comparison of transport modeling for tokamaks and EBT.** Callen, J.D. (Oak Ridge National Lab., TN). Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

57433 (DOE/ET—0112, pp 12p, Paper 15) **Radial transport in EBT with constant edge neutral flux.** Jaeger, E.F. (Oak Ridge National Lab., TN); Hedrick, C.L.; Ard, W.B. Aug 1979.

From EBT transport workshop; Gaithersburg, MD, USA (7 May 1979).

One-dimensional (1-D) radial transport equations for the ELMO Bumpy Torus (EBT) are solved assuming a constant flux of cold neutrals at the plasma edge independent of toroidal plasma parameters. With this boundary condition, thermal stability is achieved, for the first time, in the collisionless electron regime using a fully classical transport model. Results also show a parametric dependence on edge neutral pressure in the collisionless regime that is similar to that observed in experiments.

57434 (LBL—9407) **Regular and stochastic particle motion in plasma dynamics.** Kaufman, A.N. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 29p. (CONF-7906106—3). Dep. NTIS, PC A03/MF A01.

From International workshop on intrinsic stochasticity in plasmas; Cargese, Corsica, France (18 Jun 1979).

A Hamiltonian formalism is presented for the study of charged-particle trajectories in the self-consistent field of the particles. The intention is to develop a general approach to plasma dynamics. Transformations of phase-space variables are used to separate out the regular, adiabatic motion from the irregular, stochastic trajectories. Several new techniques are included in this presentation.

57435 (PPPL—1576) **Guiding-center Hamiltonian figure-8 particles in axisymmetric field-reversed configurations.** Mynick, H.E. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Sep 1979. Contract EY-76-C-02-3073. 25p. Dep. NTIS, PC A02/MF A01.

The guiding-center Hamiltonian K is derived for so-called figure-8 particles which are present in field-reversed mirror configurations, using a formalism developed previously. For such particles, the gyro-orbit cannot be approximated by a circle, and standard approaches to guiding-center theory are thus totally inapplicable. K manifests this intrinsic difference by a quite different dependence on the gyroaction, and by familiar effects such as mirroring and magnetic-gradient drifts being controlled by the radial derivative of the magnetic field strength B at the point of field-reversal, rather than by B itself, as occurs in standard guiding-center theory.

57436 (UCRL—83206) **Vectorized Fokker-Planck package for the CRAY-1.** McCoy, M.G.; Mirin, A.A.; Killeen, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1979. Contract W-7405-ENG-48. 9p. (CONF-790902—1). Dep. NTIS, PC A02/MF A01.

From Impact of advanced systems on scientific computations; Livermore, CA, USA (12 Sep 1979).

A program for the solution of the time-dependent, two dimensional, nonlinear, multi-species Fokker-Planck equation is described. The programming is written such that the loop structure is highly vectorizable on the CRAY FORTRAN Compiler. A brief discussion of the Fokker-Planck equation itself is followed by a description of the procedure developed to solve the equation efficiently. The Fokker-Planck equation is a second order partial differential equation whose coefficients depend upon moments of the distribution functions. Both the procedure for the calculation of these coefficients and the procedure for the time advancement of the equation itself must be done efficiently if significant overall time saving is to result. The coefficients are calculated in a series of nested loops, while time advancement is accomplished by a choice of either a splitting or an ADI technique. Overall, timing tests show that the vectorized CRAY program realizes up to a factor of 12 advantage over an optimized CDC-7600 program and up to a factor of 365 over a non-vectorized version of the same program on the CRAY.

57437 **Plasma diffusion due to magnetic field fluctuations.** Okuda, H.; Lee, W.W.; Lin, A.T. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Fluids;* **22**: No. 10, 1899-1906(Oct 1979).

Plasma diffusion due to magnetic field fluctuations has been studied in two dimensions for a plasma near thermal equilibrium and when the fluctuations are suprathermal. It is found that near thermal equilibrium, electron diffusion varies as β^{-2} when the collisionless skin depth is greater than the thermal electron gyroradius and is generally smaller than the diffusion due to collisions or electrostatic fluctuations for a low-β plasma. When the suprathermal magnetic fluctuation exists because of macroscopic plasma currents, electron diffusion is enhanced due to the coalescence of current filaments and magnetic islands. Magnetic field energy is found to condense to the longest wavelength available in the system and stays there longer than the electron diffusion time scale.

57438 **Equilibrium of low-aspect-ratio plasma configurations and implications on stability.** Morikawa, G.K. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Phys. Fluids;* **22**: No. 10, 1994-1999(Oct 1979).

Nonlinear effects on the stationary equilibrium of spheroidal low-aspect-ratio plasma shapes with vacuum boundaries are considered mainly using appropriate linear methods. Simple analyses of both magnetohydrodynamic and guiding center fluids with anisotropic pressures p/sub perpendicular/ and p/sub parallel/ nearly equal to the scalar pressure p are presented. Results concerning the necessary amount of axial current I_0 required for equilibrium are given and their implications for stability are described.

57439 **Response of a tokamak plasma to particle and momentum sources.** Stacey, W.M. Jr.; Sigmar, D.J. (School of Nuclear Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332). *Phys. Fluids;* **22**: No. 10, 2000-2008(Oct 1979).

The response of an axisymmetric toroidal tokamak plasma to first-order particle and momentum sources is investigated. The momentum sources drive coupled poloidal and toroidal mass flows and electrostatic field evolution which relax to asymptotic values on a time scale characteristic of the dominant viscous or external drag mechanism. The asymptotic steady-state momentum balance provides the necessary condition to completely determine the ambipolar potential, the particle fluxes, and currents in the flux surfaces and, hence, to determine transport fluxes across flux surfaces. Transport fluxes are driven across flux surfaces both by interspecies collisional momentum exchange, the usual case, and by momentum exchange between the plasma and external sources and/or drags. A generalized Ohm's law is obtained and used to determine how particle and momentum sources drive parallel currents and alter the evolution of the q profile. The theory is formulated for arbitrary plasma cross sections, beta, and collision regimes.

57440 (UCRL-Trans—11497) **High-current equilibrium.** Meyerovich, B.E.; Sukhorukov, S.T. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). Jul 1979. Translation of ITEF—56, 1979. 33p. Dep. NTIS, PC A03/MF A01.

A study was made of stationary flow of high current, when the structure of the discharge channel plasma is determined by the equilibrium in the electromagnetic field of the collective interaction of charges. It is shown that in the case of a plasma which is electrically neutral as a whole, stratification of the current takes place in such a way that the excess magnetic pressure is compensated by the electrostatic repulsion of the space charge arising near the axis as a result of the stratification. In general, the structure of high current does not meet the quasi-neutrality condition. The possible relation of plasma stratification at high current to the presence of a hot core in the hf discharge is discussed.

57441 **Magnetic reconnection in collisionless plasmas.** Coppi, B.; Mark, J.W.; Sugiyama, L.; Bertin, G. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Ann. Phys. (N.Y.);* **119**: No. 2, 370-404(Jun 1979).

A class of processes involving magnetic field reconnection, in collisionless plasmas and magnetic configurations where the field undergoes a finite change of direction, is investigated. Reconnecting modes that rely on the effects of electron Landau resonance and density gradient for their excitation are found to require the analytical or numerical treatment of four consecutive asymptotic regions. The influence of finite electron temperature gradient in the region where the effects of electron Landau resonance prevail, and the convection of energy toward the region where ion Landau resonance is dominant tend to dampen these modes. Conversely, significant distortions of the ion distribution can follow their excitation. The relevance of the obtained results to experimental observations on laboratory plasmas and in space physics is discussed. Different

processes are involved with magnetic reconnection in magnetic configurations where the field does not have appreciable shear but has a neutral surface on which it vanishes.

57442 Developments of MAKOKOT code. Equilibrium of a plasma without shell; impurities outside coronal equilibrium and hollow profiles. Blum, J. (Laboratoire d'analyse numerique de Paris VI, France); Cissoko, G. (Compagnie Internationale de Services en Informatique (CISI), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Dei Cas, R.; Mercier, C.; Morera, J.P.; Werkoff, F. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). pp 521-546 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The MAKOKOT code was developed by coupling it with a model describing the various circuits of a tokamak and the equilibrium position of the plasma and by introducing a system describing the evolution of each degree of ionization for four impurities. The differential equations for the currents in the circuits are written in terms of the flux, the expressions for which were identified by means of two-dimensional magnetostatic codes. It has thus been possible to devise a fine-scale preprogramming of the equilibrium field and to make a precise study of stability and control of plasma position, with allowance in particular for variations in β and in lsub(i) as a function of the minor radius. The results have been applied to TFR 600, a tokamak with an iron core but without a conducting shell. A study of hollow-temperature profile states has shown that if the electron thermal diffusion coefficient is too small, a thermal instability is set up, that the impurities are in these states very far from coronal equilibrium and that depending on the initial conditions it is possible, at least in certain parameter ranges, to obtain a state with either a hollow or a peaked profile.

57443 Radiation, impurity effects, instability characteristics and transport in Ohmically heated plasmas in the PLT tokamak. Bol, K.; Arunasalam, V.; Bitter, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 11-32 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Titanium-gettered deuterium plasmas, with graphite or steel limiters to define the plasma minor radius, have Zsub(eff) approximately 1 for $3x10^{13}$ <anti nsub(e)< $1x10^{14}cm^{-3}$. In ungettered discharges the density limit set by disruptions is about half the value in gettered discharges. The bolometrically measured energy flux from the whole plasma volume is 80-100% of the Ohmic input power for ungettered discharges and 50-70% for gettered ones. The strucutre of MHD modes continues to be intensively studied by means of soft X-ray detector arrays; however, the connection with the disruptive instability remains unclear. Microinstabilities, studied by means of a 2-mm homodyne scattering system, appear to be of sufficient magnitude to influence energy and particle transport. Ion energy confinement times in the central region of the plasma have been estimated to be 50-100ms. Gross electron energy confinement time increases linearly with density at constant temperature. The longest electron energy confinement times observed are approximately >40ms in dense gettered discharges, giving total energy confinement times approximately 80ms.

57444 Plasma transport in the collisional divertor scrape-off layer. Daybelge, U. (Bochum Univ. (Germany, F.R.). Inst. fuer Theoretische Physik). pp 549-559 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The structure of a collisional scrape-off layer in a tokamak with a poloidal divertor is considered. The analysis is based on the drift kinetic equation with a model pitch-angle scattering operator. The boundary condition for charged particles impinging upon the metal target plates is assumed to be perfect absorption. A proper inner- and outer-expansion scheme for the boundary value problem is suggested. A uniformly valid lowest-order solution for the distribution function in terms of the eigenfunctions of the collision operator is found. Various representations of the eigenfunctions, including a WKB approximation, are given. The solution is used to calculate the quasineutral particle densities and the selfconsistent electric potential. The source of a modified Pfirsch-Schlueter diffusion is indicated.

57445 Computer modelling and scaling of transport in tokamaks. Hughes, M.H.; Hugill, J. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.). pp 457-469 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The anomalous transport losses in tokamaks are studied using a one-dimensional computer code to compare theoretical models with the DITE experiment, and by direct calculation of diffusion losses from experimental results. These studies show that the anomalous thermal conduction increases rapidly towards the plasma boundary, that particle diffusion is slower than heat diffusion, and that the neoclassical pinch effect is required to explain the evolution of the density distribution in discharges refuelled by gas injection. Comparison of various discharges in DITE, ORMAK and TFR using normalized parameters confirms their basic similarity.

57446 Finite-beta effect on transport by current-driven drift instability in sheared magnetic field. Inoue, S.; Itoh, K. (Tokyo Univ. (Japan). Dept. of Physics); Tange, T.; Nishikawa, K. (Hiroshima Univ. (Japan). Faculty of Science); Yoshikawa, S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 777-785 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Anomalous particle and heat fluxes in a finite-β inhomogeneous plasma owing to electromagnetic current-driven drift wave fluctuations in a sheared magnetic field are calculated correct to the first order with respect to β (plasma pressure/magnetic pressure). It is shown that among various electromagnetic effects the most important is the reduction of the electron Landau resonance rate due to coupling of the drift mode to the Alfven mode. Starting from the eigenmode equations valid for arbitrary wavelengths, the dispersion relation and the mode structure are obtained by expanding the eigenfunction in terms of a complete orthonormal set. In this analysis, three smallness parameters are introduced. The result shows appreciable reduction of the growth rate by the electromagnetic effect. Anomalous particle and heat fluxes are then calculated using their general expressions derived elsewhere and the eigenmode structure obtained in this paper. It is found that the fluxes are reduced by the electromagnetic effect and that the electron heat flux is of the same order of magnitude as the ion and electron particle fluxes. A brief discussion is given on the effective equipartition time between electrons and ions which is obtained from the energy balance equation.

PLASMA PRODUCTION

REFER ALSO TO CITATION(S) 57421

57447 (CEA-R—4896) **Contribution to high Z laser created plasma studies: X ray and particle emissions.** Couturaud, J.C. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France); Toulouse-3 Univ., 31 (France)). Jan 1978. 213p. (In French). Dep. NTIS (US Sales Only), PC A10/MF A01.

This work concerns the study of an aluminum laser created plasma (lambda=1.06 μm). For laser flux smaller than 10^{13} W.cm^{-2} and for a 30 ns laser pulse it is shown that the laser beam absorption by the plasma, higher than 95%, is probably due to the inverse electron-ion bremmstrahlung. The ion emission is described and an interaction energy balance is established. Electron temperature is deduced from these measurements, performed after the interaction. Some evidence is given of the existence of recombinaison processes. X-ray emission has been studied mainly by spectroscopic methods. Plasma parameters obtained during the interaction are deduced comparing the experimental values to the numerical ones obtained by a steady state coronal model. Most of the X-ray emission appears to lie in the resonance line Heα.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 57272, 57407, 57446, 57480, 57483

57448 (COO—2218-136) **Stability of the field-reversed mirror.** Morse, E.C. (Illinois Univ., Urbana (USA)). 1979. Contract EY-76-S-02-2218. 109p. Dep. NTIS, PC A06/MF A01.

Thesis.

The stability of a field reversed mirror plasma configuration is studied with an energy principle derived from the Vlasov equation. Because of finite orbit effects, the stability properties of a field-reversed mirror are different from the stability properties of similar magnetohydrodynamic equilibria. The Vlasov energy principle developed here is applied to a computer simulation of an axisymmetric field-reversed mirror state. It has been possible to prove that the l = 0 modes, called tearing modes, satisfy a sufficient condition for stability. Precessional modes, with l = 1, 2, are found to be unstable at low growth rate. This suggests possible turbulent behavior (Bohm confinement) in the experimental devices aiming at field reversal. Techniques for suppressing these instabilities are outlined, and the

applicability of the Vlasov energy principle to more complicated equilibrium models is shown.

57449 (COO—3497-36) **Annual progress report.** Simon, A. (Rochester Univ., NY (USA). Dept. of Mechanical and Aerospace Sciences). 31 Aug 1979. Contract EY-76-S-02-3497. 14p. Dep. NTIS, PC A02/MF A01.

The research topics covered include a study of the nonlinear behavior of the drift cyclotron loss-cone instability in mirror machines and a study of the longer time behavior of the nonlinear O'Neil trapped particle saturation. The saturation amplitude for a single dominant mode near the stability onset boundary was determined for the drift cyclotron loss-cone instability for a variety of mirror-like distributions. The results are in good agreement with computer simulation studies of Cohen and Maron.

57450 (IAE—3028) **Amplifier for experiments on feedback stabilization of plasma helical instability in the TO-1 tokamak.** Mukhin, P.A.; Papkov, L.N.; Chudnovskii, A.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. 11p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Presented is the description of a tube amplifier intended for the use as a terminal cascade of the system of plasma helical instability feedback stabilization in the TO-1 tokamak. The amplifier band is 5-150 kHz. Maximum current achieved at inductive loading of 1.4 μH is 600 A. Maximum operation duration at stable supply voltages is equal to 7.5 μs. Amplifying coefficient is constant at input voltage amplitudes up to 1.75 V, helical winding current reaching values of 450-580 A. Amplifier shortcomings are a low input resistance of the low - pass filter used, and s strong frequency dependence of phase shift, conditioned mainly by phase-frequency characteristics of the filter and of the RC circuit consisting of the preamplifier output resistance and input capacity of the power amplifier.

57451 **Large mode-number tearing and twisting modes.** Hazeltine, R.D.; Strauss, H.R.; Mahajan, S.M.; Ross, D.W. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **22**: No. 10, 1932-1943(Oct 1979).

The radial width, w, of the boundary layer associated with tearing and twisting modes is always much smaller than equilibrium length scales. However, for the large mode number perturbations which seem particularly relevant to anomalous tokamak radial transport, the poloidal wavelength, k/sub perpendicular/$^{-1}$, can become short enough to cast doubt on previous analyses, which neglect finite -k/sub perpendicular/w terms. The effect of such terms on prominent electromagnetic eigenmodes is studied here, both analytically and numerically. The two methods agree qualitatively, and show that the growth rates of Δ'-driven tearing modes are reduced by finite k/sub perpendicular/w, while certain other tearing and twisting mode growth rates are enhanced.

57452 **Effect of convection on magnetohydrodynamic kink stability.** Dagazian, R.Y. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **22**: No. 10, 1952-1957(Oct 1979).

A magnetohydrodynamic boundary layer analysis is performed treating the effect of the convective term of the equation of motion near the singular surface. The nonlinear equations in this region are separable; the time evolution of the solution is determined by the Riccati equation and nonlinear harmonics are generated at wavenumbers which are multiples of the fundamental. This solution is matched to the linear solution in the outer region yielding modes reminiscent of resistive instabilities which nevertheless are not normal modes of the system.

57453 **Alfven-ion-cyclotron instability for axially bounded plasma.** Rognlien, T.D.; Watson, D.C. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Fluids;* **22**: No. 10, 1958-1968(Oct 1979).

The Alfven-ion-cyclotron instability is studied for a model where the ions are confined axially by a quadratic electrostatic well. Comparison between the homogeneous plasma dispersion relation, an effective dispersion relation including the effect of axially bouncing ions, and the complete eigenvalue solution shows that the first two approximate solutions are quite accurate for plasma lengths on the order of the ion gyroradius. The eigenmode with odd electric field symmetry is found to be the most unstable. Comparison is made with a previously reported particle simulation which imposes linear polarization for the electric field. It is found that the linear polarization constraint can give the unphysical result of instability at vanishingly small plasma β/sub perpendicular/ for certain parameters.

57454 **Simulation of the mirror drift cone instability.** Winske, D. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **22**: No. 10, 1969-1974(Oct 1979).

Results of particle simulation of the mirror drift cone instability, a high frequency (~lower hybrid) flute mode with loss-cone ions, are presented and compared with theory. Possible saturation mechanisms are discussed, and measurements of the diffusion of ions into the loss cone are presented and compared with quasi-linear theory.

57455 **Electrostatic bounce modes in mirror plasmas.** Sharp, W.M.; Berk, H.L.; Nielsen, C.E. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Fluids;* **22**: No. 10, 1975-1987(Oct 1979).

Bounce modes are plasma waves which result from the coherent bounce motion of trapped particles. Such modes can occur in mirror devices when the relative spread in electron bounce frequencies is small. When electron bounce modes have perpendicular wavelengths comparable to typical ion gyroradii and frequencies near the ion gyrofrequency or some harmonic, they couple effectively with the ions and can be destabilized by a loss-cone ion distribution. A one-dimensional integral dispersion equation for electron bounce modes in a mirror plasma is derived and solved numerically for the wave eigenfrequencies. Predicted threshold densities for bounce mode instabilities in the Baseball I and Baseball II devices are compared with experimental values. Good agreement is found for Baseball II, but in Baseball I the predicted thresholds are consistently below observed values.

57456 **Interaction of a high frequency magnetic field with the drift-cyclotron loss-cone mirror instability.** Shaing, K.; Kesner, J.; Conn, R.W. (Fusion Research Program, Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Fluids;* **22**: No. 10, 2040-2041(Oct 1979).

The effect of a small amplitude, high frequency field on drift-cyclotron loss-cone instability is investigated. With $B_1/B_0 = 5\%$ and ω/sub ce//$\omega_0 = 80$, the critical characteristic length of plasma density gradient reduces dramatically and is comparable to the finite β stabilization effect.

57457 **Finite-β/sub e/ universal-mode turbulence and Alcator scaling.** Molvig, K.; Hirshman, S.P.; Whitson, J.C. (Plasma Fusion Center and Nuclear Engineering Department, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **43**: No. 8, 582-586(20 Aug 1979).

A self-consistent theory of finite-β/sub e/ universal-mode turbulence is developed. Saturation results from resonance broadening of the electron response due to magnetic shear. Electron diffusion, for β/sub e/ > m/sub e//m/sub i/, is due to the magnetic part of the fluctuations. The diffusion coefficient, D = 0.1 [T/sub e//(T/sub i/+ T/sub e/)]^4 (m/sub e//m/sub i/β/sub e/)(L/sub s//L/sub n/)^2 v/sub i/rho/sub i/ ^{2}/L/sub n/, scales inversely with density, is independent of magnetic field, and is in excellent quantitative agreement with observations on the Alcator tokamak.

57458 **Feedback stabilization of kink instability in the TO-1 tokamak.** Arsenin, V.V.; Artemenko, L.I.; Ivanov, N.V.; Kakurin, A.M.; Molotkov, L.I.; Chudnovskii, A.N.; Shvindt, N.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Gvozdkov, Yu.V.; Cherkashin, M.Yu. (AN SSSR, Moscow. Inst. Problem Upravleniya). pp 233-245 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Experimental results on feedback stabilization of the kink instability in the TO-1 tokamak are presented. Depending on the phase shift of the feedback system, the amplitude of the magnetic-probe signal was observed either to decrease or to increase. The amplitude reduction was accompanied by a 20% decrease in the discharge voltage, as well as an increase in the electron temperature from 200 to 300eV and of the plasma density from 0.6 to $0.9 \times 10^{13} cm^{-3}$. - The feedback dashes had a stabilizing effect on the disruptive instability. - A simple theoretical model explains the experimental results.

57459 **Thermonuclear cone microinstabilities in tokamaks and anomalous alpha-particle losses.** Belikov, V.S.; Kolesnichenko, Ya.I.; Fursa, A.D. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). pp 561-575 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The possibility of a new class of thermonuclear plasma instabilities caused by an anisotropy in the alpha-particle velocity distribution is demonstrated. These instabilities may lead to an effective escape of alpha-particles from the plasma due to quasi-linear diffusion in velocity space. The conditions for excitation of instabilities on Alfven and fast magnetoacoustic waves are studied in the paper. Anomalous losses of alpha-particles caused by a magnetoacoustic plasma instability on waves propagated approximately along the magnetic field are investigated.

57460 Stability of large-aspect-ratio tokamaks in the two-fluid dissipative theory. Caldas, I.L.; Tasso, H. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). pp 637-641 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The two-fluid energy principle derived by Tasso is applied to shaped large-aspect-ratio tokamaks. Several previous results on MHD and resistive instabilities are recovered. A proof of the resistive drift-wave instability is given in a realistic geometry and with purely energetic arguments.

57461 High mode number stability of axisymmetric toroidal plasmas. Connor, J.W.; Hastie, R.J.; Taylor, J.B. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.). pp 667-674 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Plasma stability is often determined by modes with long wavelength parallel to the magnetic field and short wavelength perpendicular to it. However, these characteristics conflict with periodicity in a toroidal magnetic field with shear. This conflict can be resolved by transforming the problem to one in an infinite domain without periodicity constraints. This transformation makes possible a full investigation of ideal MHD stability of axisymmetric plasmas at large toroidal wave number n. (Small values of n can be studied by direct numerical computation - but this is impossible when n is large.) For $n>>1$ a systematic approximation is developed around an eikonal representation. In lowest order, the oscillations of each surface are decoupled and a local eigenvalue $\omega^2(PSI,y_0)$ is obtained. However, the mode structure, the parameter y_0, and the global eigenvalue are not determined in this order. In higher orders, y_0 is determined and a second eigenvalue equation is obtained which completes the determination of the mode structure and yields the global eigenvalue Ω^2. Although this higher-order theory is essential to complete the problem, all relevant information about unstable modes is contained in the lowest-order quantity $\omega^2(PSI,y_0)$. Hence, the lowest-order theory, which involves only the solution of an ordinary differential equation, is sufficient to determine stability.

57462 Theoretical beta limits and stability in non-circular tokamaks including internal separatrices. Dobrott, D.; Helton, F.J.; Moore, R.W.; Bernard, L.C.; Chu, M.S. (General Atomic Co., San Diego, CA (USA)); Tataronis, J.A.; Weitzner, H. (New York Univ., NY (USA)). pp 717-731 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Tokamaks achieve stability against MHD localized interchange instabilities through toroidally produced average magnetic well and through shear of the magnetic field lines. If the plasma β exceeds a critical value, ballooning modes can be driven unstable by plasma pressure gradients in local regions of unfavourable curvature. The critical β for these pressure-driven modes depends on the current density profiles, with flatter profiles being favoured. However, these have steep current density gradients and are destabilizing for the current-driven external kinks and axially symmetric modes in the absence of wall stabilization. Hence complementary studies of pressure- and current-driven modes are required to optimize tokamaks for maximum stable β with respect to both classes of instability. The techniques used include a fully global, numerical variational analysis of the ideal MHD theory of computed equilibria; approximate, semi-analytical localized interchange and ballooning analyses of this theory; a kinetic theory extension of the local ballooning analysis that includes the effects of individual particles and electrostatic fields neglected in ideal MHD; and an approximate, semi-analytic kink and incompressible axially symmetric mode analysis, valid for equilibria with elongated cross-sections. It is found that properly shaped doublet equilibria with β approximately 9.2% (6.8% for JET-like equilibria) may be achieved that are stable to the pressure-driven, localized interchange and ballooning modes for poloidal beta, βsub(p), <1. These equilibria may also be wall-stabilized to the current-driven kink and incompressible axially symmetric mode if the wall is placed such that the ratio of vacuum to plasma poloidal flux, PSIsub(v)/PSIsub(p), approximately 0.5.

57463 Disruptions and turbulence in tokamaks. Dubois, M.; Samain, A. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). pp 615-623 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The proposition is made that disruptions in tokamaks are due to the onset of a fine-grain turbulence: correlated kinetic and magnetic eddies liberate part of the poloidal magnetic energy and feed a hierarchy of smallest eddies ultimately dissipated by resistivity or viscosity. The turbulence propagates radially at velocities which agree with observations and produces the voltage spikes observed in q=2 disruptions.

57464 Suppression of major disruption by neutral gas injection and plasma current control in JIPP T-II torus. Fujita, J.; Itoh, S.; Kadota, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). pp 247-256 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, USSR; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Experimental results obtained by tokamak operation of JIPP T-II, a hybrid of tokamak and stellarator, are presented. In this device, plasma equilibrium in a resistive shell is obtained by means of feedback-controlled vertical magnetic field. With improvements of the control system, plasma shift can be suppressed within about +- 1cm for a plasma radius of 15cm. Operation of the device has been extended to higher plasma current and higher plasma density by applying a pulsed gas injection and a second rapid rise of plasma current. Major disruption caused by strong gas injection has been suppressed by the second rapid rise of plasma current. By this method, the electron density is raised to anti nsub(e) approximately $8x10^{13}cm^{-3}$ and the safety factor qsub(a) can be lowered to 2.5 without MHD oscillations. Reduction in the concentration of high-Z-impurities has also been observed.

57465 Dependence of ideal MHD beta limits on current density and pressure profiles. Gruber, R.; Schreiber, R.; Troyon, F. (Ecole Polytechnique Federale, Lausanne (Switzerland)); Kerner, W.; Lackner, K. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Sykes, A.; Wesson, J.A. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.). pp 593-603 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Numerical calculations of the MHD stability of a range of JET equilibria have been made. It is found that by shaping the current profile stability can be obtained for low mode numbers for values of β in excess of 10% provided the plasma surface is bounded by a conducting wall. In the absence of such a wall, all of the equilibria studied are found to be unstable to free boundary modes.

57466 MHD stability criteria for localized displacements. Mercier, C. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). pp 701-713 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Localized displacements of the second kind with a sheared magnetic field are investigated. The usual criterion of the first kind (Mercier criterion) is obtained as a limiting case. The growth rate of these instabilities is calculated. Numerical studies enable the determination of the effect of various parameters characterizing an equilibrium with circular cross-section. Finally, the stability of a non-circular cross-section case with high β-value (<20%) is numerically solved.

57467 What is the mechanism responsible for the precursors of internal disruptions. Rogister, A.; Hasselberg, G. (Association Euratom-Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). pp 809-813 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The theory of the resistive layer of the m=1 - MHD marginally stable - mode is revisited by including a finite diamagnetic drift frequency ωsup(*). The equations describing the tearing mode are approximations (k^2sub(parallel)c^2sub(e)/ωnusub(ei)<<1) of more general equations which admit another solution, i.e. the electromagnetic drift wave (k^2sub(parallel)c^2sub(e)/ωnusub(ei)>>1). For the m=1 MHD neutral mode there is no instability of the drift-tearing type, i.e. with Re ω approximately ωsup(*)sub(e), whilst the growth rate of the tearing mode is reduced. The electromagnetic drift wave is also found to be stable; this mode would, however, yield, like the tearing mode, a natural explanation for the formation of magnetic islands. It is concluded that the precursors of the internal disruption cannot be explained without taking toroidal effects into account.

57468 High-wave-number MHD-mode stability in high-pressure tokamaks. Zakharov, I.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj

Ehnergii). pp 689-699 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

A general expression for the potential energy describing the stability of high-wave-number MHD-modes is obtained by the Connor-Hastie-Taylor (CHT) method. The Mercier criterion is derived in the framework of the CHT method. The calculation of a critical pressure profile is presented for a plasma column with circular magnetic surfaces.

57469 Hydromagnetic stability studies using the finite element method. Boyd, T.J.M. (Univ. of North Wales, Bangor); Gardner, G.A.; Gardner, L.R.T. pp 255-274 of Finite elements in fluids. Volume 2. Mathematical foundations, aerodynamics and lubrication. Gallagher, R.H.; Oden, J.T.; Taylor, C.; Zienkiewicz, O.C. (eds.). New York, NY; Wiley and Sons (1975).

From International symposium on finite elements methods in flow problems; Swansea, UK (7 Jan 1974).

The model of a linear pinch is described and the functional governing small perturbations of the equilibrium state are given. A description of the method of solution using the case of a pinch with fixed boundary is given. The free boundary pinch is studied in detail and the solutions, in appropriate limits, are compared with analytic expressions. A linear pinch with elliptic cross section was studied as a preliminary to using the finite element method to analyze toroidal belt pinch configurations. (MOW)

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 57421

57470 (COO—3004-26) **Generalization of kinetic ponderomotive effects.** Schamel, H.; Schmidt, G. (Ruhr-Univ., Bochum (Germany, F.R.); Stevens Inst. of Tech., Hoboken, NJ (USA)). Jun 1979. Contract EY-76-S-02-3004. 10p. Dep. NTIS, PC A02/MF A01.

The plasma response to electrostatic wave packets with a slowly varying envelope is investigated, including dynamical friction between electrons and ions. New effects include current generation due to friction and the emergence of a modified ponderomotive potential due to Doppler shift of the wave frequency seen by particles.

57471 Fluctuations, diffusion and beam-induced currents in the Culham Levitron. Ainsworth, N.R.; Alcock, M.W.; Bradford, R.E. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.). pp 745-761 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Measurements of the radial profile of fluctuation frequency and amplitude in the Culham Levitron have revealed a marked radial variation of the low-frequency component related to the integer rational surfaces. This low-frequency component has $\omega << \omega_{sub}(*e)$ and ksub(y)asub(i) approximately 0.05 and is both shear and nabla B stabilized. The local diffusion coefficient derived from the temperature and density profiles is also reduced by shear. The results are compared with several theoretical models, with particular emphasis on the temperature gradient and resistive-g modes. A Fokker-Planck calculation of the plasma current driven by a beam of fast ions has recently been carried out for a wide range of values of vsub(e)/vsub(b), the ratio of electron thermal to beam velocity. The net current has a different dependence on electron temperature to that predicted by the conventional theory, which assumes a displaced Maxwellian distribution for the electrons. In particular, this theory predicts that for vsub(e)>0.74 vsub(b) and Z=1 the net current is in the opposite direction to the fast ion current. The theory is in good agreement with the experimental results.

57472 Radio frequency electric fields in ion cyclotron excitation of multispecies plasma. Tang, J.T.; Stenzel, R.L.; Kim, H.C. (TRW Defense and Space Systems Group, One Space Park, Redondo Beach, California 90278). *Phys. Fluids;* **22**: No. 10, 1907-1912(Oct 1979).

The self-consistent rf electric field in ion cyclotron excitation of a multispecies plasma is measured and compared with linear plasma theory. For wave propagation perpendicular to the magnetic field B/sub z/ (k/sub z/=0), the rf electric field has minima at major and minor ion cyclotron frequencies f_1, f_2, respectively. Near f/sub α/, where f/sub α/ is the ion cyclotron frequency of species α, the field is proportional to $\Delta f = f - f_{sub\,\alpha}$. The line width about f/sub α/ is proportional to r/sub α/ equivalent the ratio of the ion concentration n/sub α/ to the total ion density n_0. As the concentration of minor ion species decreases ($r_2 <$ or $\approx 10\%$), the field at frequencies near f_2 increases sufficiently to accelerate the minor ions to high energy (> 100 eV).

57473 Analytic eigenvalue equations for collisionless drift waves in tokamaks. Catto, P.J.; Tsang, K.T. (Science Applications, Inc., Laboratory for Applied Plasma Studies, Boulder, Colorado 80302). *Phys. Fluids;* **22**: No. 10, 2014-2019(Oct 1979).

Recently, collisionless drift waves in sheared magnetic fields were shown to be stable. The validity of the analytic model employed in one of these investigations is examined in detail.

57474 Experimental observation of current generation by unidirectional electron plasma waves. Wong, K.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **43**: No. 6, 438-441(6 Aug 1979).

A slow-wave structure was used to launch electron plasma waves traveling preferentially in one direction. The current generated by the waves was observed. The magnitude of the current can be estimated from momentum conservation in the wave-particle interaction process.

FUSION POWER PLANT TECHNOLOGY

57475 (UCRL-Trans—11476) **Research on open thermonuclear systems at the Novosibirsk Institute of Nuclear Physics.** Ryutov, D.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Apr 1979. Translated from Problems of atomic science and engineering, a scientific and technical collection, Thermonuclear Fusion Series, No. 1-2, 1978. 27p. Dep. NTIS, PC A03/MF A01.

A review of research progress at Novosibirsk on open systems is given. The review covers rotational confinement and ambipolar traps in open systems. Future experiments are discussed. (MOW)

57476 Doublet research at General Atomic Company. Freeman, R.L.; Adcock, S.J.; Baker, D.R. (General Atomic Co., San Diego, CA (USA)). pp 157-165 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Vertically elongated tokamaks are widely recognized to have significant advantages for tokamak fusion reactors. Control of the current density profile is essential for optimizing the detailed plasma cross-sectional shapes for MHD stability in order to attain the full potential of elongated configurations. Optimization studies of the doublet configuration utilize a simple model to understand the influence of current density profiles on plasma shape control. A two-dimensional transport code has also been used to demonstrate the use of neutral beam heating to control the plasma shape in Doublet III. Experimental studies on Doublet IIA to investigate the use of lower hybrid waves for auxiliary heating and current profile control are described. A Doublet III status report concludes the paper.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 56928, 57508

57477 (CONF-790803—51) **High temperature fusion reactor design.** Harkness, S.D.; dePaz, J.F.; Gohar, M.Y.; Stevens, H.C. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 9p. Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

Fusion energy may have unique advantages over other systems as a source for high temperature process heat. A conceptual design of a blanket for a 7 m tokamak reactor has been developed that is capable of producing 1100°C process heat at a pressure of approximately 10 atmospheres. The design is based on the use of a falling bed of MgO spheres as the high temperature heat transfer system. By preheating the spheres with energy taken from the low temperature tritium breeding part of the blanket, 1086 MW of energy can be generated at 1100°C from a system that produces 3000 MW of total energy while sustaining a tritium breeding ratio of 1.07. The tritium breeding is accomplished using Li_2O modules both in front of (6 cm thick) and behind (50 cm thick) the high temperature ducts. Steam is used as the first wall and front tritium breeding module coolant while helium is used in the rear tritium breeding region. The system produces 600 MW of net electricity for use on the grid.

57478 (WFPS-TME—106) **Demonstration Tokamak Hybrid Reactor (DTHR) blanket design study, December 1978.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.). 1978. Contract EG-77-C-02-4544. 146p. Dep. NTIS, PC A07/MF A01.

This work represents only the second iteration of the conceptual design of a DTHR blanket; consequently, a number of issues important to a detailed blanket design have not yet been evaluated. The most critical issues identified are those of two-phase flow maldistribution, flow instabilities, flow stratification for horizontal radial inflow of boiling water, fuel rod vibrations, corrosion of clad and structural materials by high quality steam, fretting and cyclic loads. Approaches to minimizing these problems are discussed and experimental testing with flow mock-ups is recommended. These implications on a commercial blanket design are discussed and critical data needs are identified.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 57008, 57009

57479 (UCRL-Trans—11499) **Magnetically compressed discharge. The generation of superstrong magnetic fields.** Alikhanov, S.G.; Glushkov, I.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Aug 1979. Translation of IAE—3016, 1978. 13p. Dep. NTIS, PC A02/MF A01.

A discharge in a hydrogen plasma which is bounded on one side by a solid wall and on the other by a magnetic field is considered. The volt-ampere characteristic and the size of the current-carrying layer are determined on the basis of calculations made for a broad range of magnetic field strengths. The feasibility of generating superstrong magnetic fields ($H > 10^7$ Oe) by means of a magnetically compressed discharge and a cylindrical shaping shell is demonstrated.

57480 Magnetic 'islandography' in tokamaks. Callen, J.D.; Waddell, B.V. (Oak Ridge National Lab., TN (USA)); Carreras, B. (Junta de Energia Nuclear, Madrid (Spain)). pp 415-431 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Tearing modes are shown to be responsible for most of the experimentally observed macroscopic behaviour of tokamak discharges. The effects of these collective magnetic perturbations on magnetic topology and plasma transport in tokamaks are shown to provide plausible explanations for: internal disruptions (m/n=1); Mirnov oscillations (m/n=2,3,...); and major disruptions (coupling of 2/1-3/2 modes). The non-linear evolution of the tearing modes is followed with fully three-dimensional computer codes. The effects on plasma confinement of the magnetic islands or stochastic field lines induced by the macroscopic tearing modes are discussed and compared with experiment. Finally, microscopic magnetic perturbations are shown to provide a natural model for the microscopic anomalous transport processes in tokamaks.

57481 Electron heat conductivity of the plasma across a "braided" magnetic field. Kadomtsev, B.B.; Pogutse, O.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 649-662 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Small perturbations of magnetic fields in toroidal magnetic traps can lead to a very complicated behaviour of magnetic field lines. These fields are considered to be random, and both magnetic line diffusion and electron heat conductivity produced by the diffusion of magnetic field lines are studied.

57482 Effects of shaping and compression on confinement and stability in a tokamak. McGuire, K. (Oxford Univ. (UK)); Robinson, D.C.; Wootton, A.J. (Euratom/UKAEA Fusion Association, Abingdon (UK). Culham Lab.). pp 335-348 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Results of shaping the plasma cross-section into an elliptic, a triangular and a D-shaped form are described. Stable operation has been obtained with compressed and non-circular plasmas at currents up to 20kA, densities of $1\text{-}3\times10^{13}\text{cm}^{-3}$ and electron temperatures up to 300eV. A central value of $\beta>=3\%$ and energy confinement times in excess of 1ms have been obtained. Axisymmetric instabilities, passively controlled, limit the maximum distortion allowed. Confinement times are found to increase with increasing semi-axis ratio (vertical ellipse) or when the plasma edge is defined by a separatrix (triangular plasmas). Sawtooth and m=1 oscillations of the X-ray flux in triangularly distorted plasmas are described. Compression experiments show the importance of detaching the plasma from the limiter. The energy confinement time increases from 0.2ms to 1.0ms, and the plasma energy increases more than expected for an adiabatic compression.

57483 Feedback stabilization of magnetic islands in tokamaks. Monticello, D.A.; White, R.B.; Rosenbluth, M.N. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp 605-613 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The major tokamak disruption limits the operation of present tokamaks, and present experimental evidence points to the m=2, n=1 tearing mode as being primarily responsible for its occurrence. Numerical codes capable of following the full non-linear history of this mode have been used to develop and test feedback stabilization schemes utilizing helical coils mounted on the interior of the tokamak wall. It is found that a phase-detecting feedback system is capable of stabilizing the magnetic island at an island width of a few per cent of the tokamak minor radius, requiring a coil current of one to two kiloamps for typical discharge parameters (in PLT).

57484 Shaping and internal structure in non-circular tokamaks. Toyama, H.; Iwahashi, A.; Kaneko, H. (Tokyo Univ. (Japan). Dept. of Physics). pp 365-375 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Experiments on two non-circular tokamaks, TNT-A at Tokyo University and HYBTOK-1 at Nagoya University are presented. In TNT-A, active and passive control of the plasma shape has been carried out successfully. Plasma properties were studied in relation to the shaping field curvature. Diagnostics were made by Thomson-scattering experiments and by monitoring the poloidal field configuration inside and outside the plasma. An appropriate curvature of the shaping field was found to maintain a D-shaped stable plasma of moderate temperature (Tsub(e) approximately 150eV) and relatively low safety factor (qsub(a) approximately 2), with the elongation ratio of approximately 1.5. Disruptive instabilities were studied in relation to the m=2 kink mode and q=1 internal singular surface. Improvements in the MHD properties in tokamaks due to non-circularity have been confirmed. In HYBTOK-1 basic problems relating to lower hybrid heating were studied. Reflection of the input power was minimized by an on-line matching network, and a new type of antenna with a favourable feature for launching the lower hybrid wave was developed. The computed group velocity trajectory was drawn for the magnetic configuration of HYBTOK-1. The RF field of the pump wave was measured with an RF probe. A maximum field amplitude appeared for a certain toroidal magnetic field, consistent with the prediction based on the trajectory. Finally it was confirmed, by analysing the high-frequency signal picked up with an electrostatic double probe, that the RF power causes a microinstability of decay type.

57485 Convective motion of impurity ions on rational magnetic surfaces. Wobig, H. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). pp 643-646 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Diffusion and convection of a plasma with impurity ions is considered in the limit of a collisional multifluid model. In toroidal geometry local sources of impurities can give rise to convective cells on rational magnetic surfaces. The size of the convective cells depends on shear, rotational transform and dissipative processes.

57486 Nonlinear analysis of a superconducting magnet of fusion reactor. Chang, T.Y.; Suzuki, H. (Akron Univ., OH (USA). Dept. of Civil Engineering); Reich, M. (Brookhaven National Lab., Upton, NY (USA)). pp L5/3 1-11 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Superconducting magnets being considered for the design of experimental fusion reactors consist of multiphase materials, involving superconductors, stabilizers, structural reinforcement and insulators. From the structural standpoint, the magnets will behave differently for the corresponding loads. Under operating conditions, the magnets will probably respond in a linear elastic manner. However, under abnormal conditions elastic-plastic deformations may become important. Furthermore, since the magnets are laminated structures, delamination of the layers and interlaminar slip may occur due to the loss of bonding. Such action would in turn reduce the overall stiffness of the structure and cause stress redistribution and strain accumulation in localized region. In this paper, two constitutive models are proposed to represent the structural response of the superconducting magnet. The constitutive models for the two-di-

mensional and three-dimensional states of deformation are implemented into a nonlinear finite element program. Numerical results are obtained for a typical superconducting magnet design to demonstrate the effects of elastic-plastic deformations and interlaminar slip.

57487 Finite element methods for analysis of toroidal field coils in fusion devices. Charman, C.M. (General Atomic Co., San Diego, CA (USA)). pp M2/7 of Structural mechanics in reactor technology. Vol. M. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

57488 Three-dimensional inelastic evaluation of a controlled MFE (Magnetic Fusion Energy) reactor magnet. Lehner, J.; Reich, M.; Powell, J. (Brookhaven National Lab., Upton, NY (USA)). pp L5/4 of Structural mechanics in reactor technology. Vol. L. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

POWER SUPPLIES, ENERGY STORAGE

57489 (CONF-790815—20) **Operating characteristics of the 1.5 MJ pulsed superconducting coil.** Kim, S.H.; Wang, S.T.; Lieberg, M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Madison, WI, USA (21 Aug 1979).

It is demonstrated for the first time that a relatively large cryostable superconducting coil can be pulsed with relatively low ac losses at high ramping rates. The low ac losses with limited current sharing have been achieved by insulating the surface of the basic cable with thin organic film. The ac losses at 9 T/s are about 0.1% of the stored energy in the coil. After more than 4000 pulsing cycles, no changes in the pulsing characteristics and cryostability of the coil have been observed. The quench current of the coil is approximately 1 kA higher than the critical current of the coil.

57490 (INIS-mf—4820, pp 5-9) **Development and investigation of induction superconducting energy storage devices.** Dedyurin, A.M.; Dinaburg, L.B.; Dubasov, V.G.; Kostenko, A.I.; Monoszon, N.A.; Mymrikov, V.V.; Sereda, G.E.; Trokhachev, G.B.; Fokeev, V.F.; Frolov, A.D. 1977. (In Russian).

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

The design of inductive superconducting storage devices with a monolithic winding for an energy of 10, 30, 80, 200, and 230 kJ with liquid-helium cooling is described, and the results of their investigation are presented. The windings were made of a superconducting transposed seven-strand cable consisting of six composite and one copper conductor, the last being in the center of the cable. The cable was impregnated with indium and insulted with cotton braiding. The composite conductors had a copper matrix and niobium-titanium superconducting filaments. The diameter of the composite conductors for different storages varied from 0.5 to 1 mm; the diameter of the superconducting filaments was 60-120 μm. After 5-6 switchings, a current close to the calculated one was attained in all the devices. The maximum rate of field increase during the charging of the devices was several hundredths of T/s without transition to the normal state. The described devices may be used in developing thermonuclear theta pinches.

57491 (UCRL—82547) **Double-sided electron beam generator for KrF laser excitation.** Schlitt, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1979. Contract W-7405-ENG-48. 14p. (CONF-790622—28). Dep. NTIS, PC A02/MF A01.

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

Several laser systems excited by electron beam have been identified as candidates for pump sources for laser fusion applications. The electron beam generators required must be compact, reliable and capable of synchronization with other system components. A KrF laser, designated the A amplifier, producing a minimum output of 25 J was needed for the RAPIER (Raman Amplifier Pumped by Intensified Excimer Radiation) system. A double-sided electron beam system was designed and constructed specifically for this purpose and has produced > 35 J of KrF output. Each of the two electron beam machines in the system operates with an rms jitter of 0.4 ns and together occupy ~ 3.5 m^2 of floor space.

COOLING SYSTEMS

57492 (CONF-790802—58) **Thermal analysis of a high-temperature falling bed fusion reactor blanket.** DePaz, J.F.; Harkness, S.D. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 25p. Dep. NTIS, PC A02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A high temperature, falling bed blanket has been designed for a tokamak fusion reactor. The design centers on the use of a gravity flow of 0.5 to 1.5 cm diameter Al_2O_3 balls as the high temperature heat transfer media. This system has the advantage of being able to produce process heat at temperatures in excess of 1000°C while maintaining structural temperatures at approximately 400°C. Pumping powers for the system are low. A thermal hydraulic analysis of a representative blanket module has, however, identified several potential problem areas. The most important of these is the fact that unless steps are taken to avoid it, as much as 40% of the total power deposited in the high temperature bed is extracted as low temperature heat through the active cooling of the structural shell of the duct channeling falling ceramic balls. The use of more insulating liner bricks was explored and rejected due to the excessively high temperatures that resulted in these bricks. Velocity partitioning of the falling balls appears to be the most promising method for reducing the loss of energy to the actively cooled structure.

HEATING AND FUELING SYSTEMS

57493 (COO—2766-1) **Dynamics of relativistic e-beam diodes. Final report, June 1, 1978-May 31, 1979.** (Massachusetts Inst. of Tech., Cambridge (USA). Research Lab. of Electronics). 1979. Contract EY-76-S-02-2766. 20p. Dep. NTIS, PC A02/MF A01.

The reflex diode was studied both with and without a prepulse plasma filling the anode-cathode gap and at least qualitative agreement with the 1-d theory was found. The prepulse plasma causes the diode to operate in a low impedance mode throughout the pulse with no early high impedance phase normally associated with the reflex diode. In addition, some preliminary investigations of the 2-d characteristics of the reflex mode were made using x-ray pinhole photography from bremsstrahlung emission at the anode foil. Studies of prepulse plasmas on high ν/γ pinch diodes have also been conducted.

57494 (LA-UR—79-2220) **Rail gun powered by an integral explosive generator.** Peterson, D.R.; Fowler, C.M. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 12p. (CONF-790741—8). Dep. NTIS, PC A02/MF A01.

From DOE impact fusion workshop; Los Alamos, NM, USA (10 Jul 1979).

We propose the use of a rail gun powered by an explosive magnetic flux compression generator built into the rail gun itself in which the rails of the gun are driven together behind the projectile by explosives. The magnetic field established between the rails by an initial current supplied by an external source at the breech of the gun is trapped and compressed by the collapsing rails to accelerate the projectile down the bore of the gun.

57495 (LA-UR—79-2329) **Use of lasers for accelerator diagnostics. I. Elementary concepts.** Aldridge, J.P.; Hayward, T.D. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 28p. (CONF-791102—1). Dep. NTIS, PC A03/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The coming development of high current linear accelerators for H^- ions requires improvement in diagnostic instrumentation that will permit accurate determination of the occupied phase space. A laser photo-detachment method is proposed to provide this new capability. The fundamental processes that are operative are explored and limitations to the accuracy of measurements using this diagnostic are considered. Questions to be addressed subsequently include the experimental arrangement required to reconstruct the detailed beam profile from the measurements at several angles.

57496 (LBL—9146) **Graphical human interface to a neutral beam system.** Elischer, V.; Fiddler, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 7p. (CONF-790806—3). Dep. NTIS, PC A02/MF A01.

From SIGGRAPH '79; Chicago, IL, USA (6 Aug 1979).

A color graphics system has been designed and implemented as the human interface to a 120KV, 60 amp neutral beam source being built at Lawrence Berkeley Laboratory for Tokamak Fusion Test Reactors. The system is based upon a 64 x 64 touch panel and allows a number of control and high level analysis displays to be brought up on any of three monitors. Included among the displays are a Super-oscilloscope package, a data acquisition timing package, numerical control displays and pictograms. The system succeeds in being very friendly and easy to learn for the operator. All control is via the touch panel and a set of six knobs and two keypads.

57497 (UCRL-Trans—11487) **Plasma physics and problems of controlled thermonuclear reactions.** Tolok, V.T. (ed.). (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). Jun 1979. Translation of KhFTI—77-39, 1977. 164p. Dep. NTIS, PC A08/MF A01.

Separate abstracts were prepared for each of the nine included papers. (MOW)

57498 (UCRL-Trans—11487, pp 1-19) **Integral model of a pulsed coaxial plasma gun.** Belikov, A.G.; Gonacharenko, V.P.; Goncharenko, D.K.; Derepovskii, N.T. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The present paper gives a description of an integral model of a pulsed coaxial gun and the results obtained on the basis of this model, and determines some similarity factors for a coaxial gun.

57499 (UCRL-Trans—11487, pp 20-40a) **Investigation of the operation of a pulsed coaxial plasma gun in the MHD approximation.** Belikov, A.G.; Goncharenko, V.P.; Goncharenko, D.K.; Derepovskii, N.T.; Nikol'skii, I.K. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The present paper gives a systematic analysis of the nonstationary magnetohydrodynamic model of plasma acceleration in the channel of a pulsed coaxial gun with an inhomogeneous initial plasma density distribution along the gun electrodes.

57500 (UCRL-Trans—11487, pp 41-56) **Investigation and optimization of high-power electrodynamic plasma accelerators.** Vasil'ev, V.I.; Zhitlukhin, A.M.; Solov'eva, V.G.; Skvortsov, Yu.V.; Umrikhin, N.M. (Inst. of Atomic Energy, Moscow, USSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

It was established that the energy and other parameters of the plasma burst of an electrodynamic accelerator depend heavily on the shape and size of the electrodes. A method has been found for rough matching of the accelerator to the energy storage device. This method is based on the model calculation. Good agreement is seen between the theoretical calculations and experimental results in terms of increasing the velocities and energy content of the plasma bursts. Plasma bursts have been obtained with an average velocity of 6 to 7 x 10^7 cm/s and a leading-edge velocity of 10^8 cm/s. The energy content of a burst is 100 to 130 kJ.

57501 (UCRL-Trans—11487, pp 57-77) **Turbulent processes in a pulsed coaxial plasma gun.** Kalmykov, A.A.; Kutsyn, A.A.; Maznichenko, M.E.; Nikol'skii, I.K.; Pavlichenko, O.S.; Shevchuk, B.A. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

A detailed investigation is presented of the basic processes accompanying the fast acceleration regime in pulsed plasma guns, and the important part of the turbulent processes that develop during plasma acceleration and that determine ion acceleration is demonstrated.

57502 (UCRL-Trans—11487, pp 78-86) **Investigation of neutron and x radiation on the MK-200 device.** Bikmatov, R.G.; Vasil'ev, V.I.; Gavrilov, V.V.; Goryacheva, N.V.; Kiskin, A.D.; Umrikhin, N.M.; Yaroslavskii, A.I. (Inst. of Atomic Energy, Moscow, USSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The neutron and x-radiation from the region of the focus that arises at the end face of the inner electrode in a pulsed coaxial plasma gun was studied. Research on the plasma focus in both systems similar to the one described in the present paper (a Meisertype plasma focus) and a noncylindrical z-pinch has been conducted for many years at various laboratories throughout the world.

57503 (UCRL-Trans—11487, pp 87-96) **Measurement of neutron yield from the plasma of a coaxial gun.** Zolototrubov, I.M.; Krasnikov, A.A.; Kurishchenko, A.M.; Novikov, Yu.M.; Poryatui, V.S.; Tolstolutskii, A.G. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

A study of the operation of a coaxial plasma gun running on hydrogen showed that under certain conditions, determined by the delay time between the admission of gas and the supply of voltage to the electrodes, the coaxial gun generates a plasma that is distinguished by high values of the parameters. On the other hand, the application of a certain quasi-stationary longitudinal magnetic field to the gun leads to a still greater increase in the parameters of the plasma generated. On the basis of these features of the operation of the apparatus, an attempt was made to determine the neutron yield when hydrogen was replaced by deuterium in order to estimate the ion temperature from the resultant yield and to compare this temperature with the results obtained from hydrogen.

57504 (UCRL-Trans—11487, pp 97-102) **Formation of shock waves in high-density plasma bunches on impact with a magnetic barrier.** Kalmykov, A.A.; Trubchaninov, S.A. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The operating conditions of the coaxial source were selected so that the conditions for shock wave formation were fulfilled. The bunch velocity was $v_0 = 5$ to 8 x 10^6 cm/s, density n ~ 10^{14} to 10^{15} cm^{-3}, temperature T/sub e/ ≈ T/sub i/ ≈ 3 eV, ion-ion collision time tau/sub ii/ 0.05 to 0.1 μs, transit time of the bunch across the interaction region tau/sub tr/ ~ 4 μs, and time of formation of the shock front tau ~ 1 μs. A double electrical probe and a local magnetic probe were used to make measurements of the radial distributions of density and the displaced magnetic field in different cross sections of the stopper.

57505 (UCRL-Trans—11487, pp 103-132) **Investigation of high-energy plasma burst formation in a complex plasma injector system.** Kalmykov, A.A.; Tereshin, V.I.; Chebotarev, V.V.; Yakubovskii, V.G. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The present paper presents an investigation of the shaping properties of a range of the magnetic field configurations indicated for producing high-energy, impurity-free plasma bursts with low divergence.

57506 (UCRL-Trans—11487, pp 133-161) **Peculiarities of beam formation from a moving dense plasma for spectral analysis of the ion component.** Zavada, P.I.; Kalmykov, A.A.; Tereshin, V.I.; Chebotarev, V.V.; Yakubovskii, V.G.; Maslov, A.V. (Kharkov Physicotechnical Inst., SSR). Jun 1979. Translated from KhFTI—77-39, 1977. Dep. NTIS, PC A08/MF A01.

In Plasma physics and problems of controlled thermonuclear reactions.

The experiments conducted fall under two series. The main part of the experiments, which was connected with the analysis proper of the separation and formation of ion beams from a moving plasma, was conducted by using high-power plasma bursts. Some peculiarities of the analysis of ion spectra using preacceleration were studied by means of weak-current Li^+ ion beams.

57507 **Comparison of different re-fuelling methods for divertor tokamaks, numerical modelling of pellet-plasma interaction, and injection speed of a re-fuelling pellet.** Duechs, D.F.; Haas, G.; Keilhacker, M.; Lackner, K.; Lengyel, L.L. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Chang, C.T. (Risoe National Lab., Roskilde (Denmark)). pp 315-330 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The paper consists of three parts. In part A, the expected performances of cold-gas inlet, pellet injection and cluster injection for re-fuelling a divertor tokamak are compared, using a stationary plasma model. The calculations indicate that ASDEX-size tokamaks can be re-fuelled by a combination of cluster injection and gas puffing or by pellet injection, pellet velocities of a few $100ms^{-1}$ being sufficient for penetration of the scrape-off layer. - In part B, the pellet-plasma interaction is investigated in detail by combining a pellet ablation model with a time-dependent multi-regime tokamak transport code. The results indicate that if the ablating pellet is regarded as a cold-neutral-particle source traversing the plasma, rather high injection frequencies (600 to 900Hz) or high pellet velocities (few $1000ms^{-1}$) are required to compensate the substantial particle losses inherent in divertor tokamaks. - In part C, the speed required to inject a pellet of a given radius to a pre-determined depth in a reactor and in some experimental devices is estimated.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

57508 (CONF-790803—52) **Chemical processing of liquid lithium fusion reactor blankets.** Weston, J.R.; Calaway, W.F.; Yonco, R.M.; Hines, J.B.; Maroni, V.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

A 50-gallon-capacity lithium loop constructed mostly from 304L stainless steel has been operated for over 6000 hours at temperatures in the range from 360 to 480°C. This facility, the Lithium Processing Test Loop (LPTL), is being used to develop processing and monitoring technology for liquid lithium fusion reactor blankets. Results of tests of a molten-salt extraction method for removing

impurities from liquid lithium have yielded remarkably good distribution coefficients for several of the more common nonmetallic elements found in lithium systems. In particular, the equilibrium volumetric distribution coefficients, D/sub v/ (concentration per unit volume of impurity in salt/concentration per unit volume of impurity in lithium), for hydrogen, deuterium, nitrogen and carbon are ~ 3, ~ 4, > 10, ~ 2, respectively. Other studies conducted with a smaller loop system, the Lithium Mini-Test Loop (LMTL), have shown that zirconium getter-trapping can be effectively used to remove selected impurities from flowing lithium.

57509 (DOE/EDP—0052) **Environmental development plan: magnetic fusion.** (Department of Energy, Washington, DC (USA)). Sep 1979. 73p. Dep. NTIS, PC A04/MF A01.

This Environmental Development Plan (EDP) identifies the planning and management requirements and schedules needed to evaluate and assess the environmental, health and safety (EH & S) aspects of the Magnetic Fusion Energy Program (MFE). Environment is defined to include the environmental, health (occupational and public), and safety aspects.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 57022, 57491

57510 (LLL-MISC—107) **Shiva Nova CP and D interim report. Laser fusion program.** Gilmartin, T.J.; Meier, C.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 825p. Dep. NTIS, PC A99/MF A01.

Extensive information is given for each of the following topics: (1) project description, (2) laser system design, (3) optics, (4) mechanical systems, (5) power conditioning, (6) control, alignment, and diagnostics, (7) target systems, (8) building construction, and (9) project management. (MOW)

57511 **Interaction of 1.06 μm laser radiation with high Z disk targets.** Rosen, M.D.; Phillion, D.W.; Rupert, V.C.; Mead, W.C.; Kruer, W.L.; Thomson, J.J.; Kornblum, H.N.; Slivinsky, V.W.; Caporaso, G.J.; Boyle, M.J.; Tirsell, K.G. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **22**: No. 10, 2020-2031(Oct 1979).

Gold disks have been irradiated with 1.06 μm laser light at intensities between 7 x 10^{13} and 3 x 10^{15} W/cm^2, and pulse lengths between 200 and 1000 psec. Due to the high Z and long pulse, inverse bremsstrahlung becomes an important absorption mechanism and competes strongly with resonance absorption and stimulated scattering. In addition to measured absorptions, data on the temporal, spatial, angular, and spectral characteristics of the x-ray emission are presented. Temporally and spectrally resolved back-reflected light, and polarization-dependent sidescattered light are detected, providing estimates for the amount of stimulated scattering and of the coronal electron temperature. Inhibited electron thermal conduction and nonlocal thermodynamic equilibrium ionization physics play key roles in bringing numerical simulations of these experiments into agreement with all of the above-mentioned data.

57512 **Raman pulse compression of excimer lasers for application to laser fusion.** Murray, J.R.; Goldhar, J.; Eimerl, D.; Szoke, A. (Univ of Calif, Lawrence Livermore Lab). *IEEE J. Quant. Electron.;* **QE-15**: No. 5, 342-368(May 1979).

Application of efficient ultraviolet excimer lasers such as the 248 nm KrF laser to laser fusion requires that long laser pulses be efficiently converted to short pulses at high intensity. The backward Raman amplifier is shown to be a promising candidate for this application. Gain, saturation, and limits to amplifier performance are described. It is shown that pump beams of poor spatial quality may be converted to output beams of high spatial quality. Several common gaseous vibrational Raman scatterers are discussed, and it is shown that a simple KrF-pumped backward Raman amplifier using methane at atmospheric pressure will have a saturation fluence near 1 J/cm;sup 2; and can produce an output five times as intense as the pump in a ten times shorter pulse with an efficiency of about 50 percent. Design tradeoffs and possible techniques for further improving the performance of such amplifiers are discussed.

57513 **Optical pulse compressor systems for laser fusion.** Ewing, J.J.; Haas, R.A.; Swingle, J.C.; George, E.V.; Krupke, W.F. (Univ of Calif, Lawrence Livermore Lab). *IEEE J. Quant. Electron.;* **QE-15**: No. 5, 368-379(May 1979).

The advantages and limitations of combined backward wave Raman pulse compression and pulse stacking for inertial fusion applications are discussed. A description of the major technological limitations which drive the designs of large (200 kJ) systems and some nominal systems parameters for a terawatt prototype stacker-compressor laser system are given. It is shown that a viable short wavelength laser fusion driver employing this concept can be expected to provide an overall power multiplication of 50 with a total systems efficiency of over 3 percent.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

57514 (ORO—4721-T1) **Hydrogen diffusion, dissolution and permeation of nonmetallic solids.** Elleman, T.S.; Rao, D.; Verghese, K.; Zumwalt, L. (North Carolina State Univ., Raleigh (USA). Dept. of Nuclear Engineering). 1979. Contract EY-76-S-05-4721. 104p. Dep. NTIS, PC A06/MF A01.

A review of hydrogen diffusion, dissolution and permeation in metal oxides, carbides, nitrides, halides and hydrides is presented. Results are organized by compound and an effort has been made to resolve differences between measured results where wide disparities exist. The document has been prepared to provide needed data for the development of fusion reactor blankets but the results should be generally useful in technologies that involve interactions between hydrogen and non-metals.

57515 **Results from the divertor injection tokamak experiment (DITE).** Axon, K.B.; Baxter, G.A.; Burt, J. (UKAEA, Abingdon. Culham Lab.). pp 51-64 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The paper contains a review of results obtained on the DITE experiment over the last two years and previously unpublished data on plasma stability, energy and particle transport, and hydrogen recycling. The new 1.2-MW neutral-injection system is described, with preliminary results of injection experiments into a 150-kA discharge.

57516 **Investigation of tokamak T-12 plasma with two axisymmetric divertors.** Bortnikov, A.V.; Brevnov, N.N.; Gerasimov, S.N.; Zhukovskii, V.G.; Kuznetsov, N.V.; Maksimov, Yu.S.; Pergament, V.I.; Khimchenko, L.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 387-398 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

T-12 is a tokamak with an elongated plasma cross-section and an axisymmetric divertor. The characteristics of the divertor, its effect on the plasma parameters, the screening-out of impurities by the divertor, and plasma and divertor layer oscillations have been studied. The plasma parameters are: electron temperature Tsub(e)=300-400eV, ion temperature Tsub(i)=130eV, density anti nsub(e)(0)=4x10^{13}cm^{-3}. The results obtained are as follows: Both duration and amplitude of the discharge current increase, the plasma density distribution becomes flatter, and the radiative energy loss to the wall becomes uniform with the use of a divertor; the relative radiation loss is reduced by one half; particle and energy outflow to the copper shell due to charged-particle leakage is negligible; the plasma density distribution in the divertor layer does not vary with time; the divertor layer diffusion rate is less than one tenth of the Bohm diffusion coefficient; the divertor screens the impurities out; screening-out of iron is more effective than that of carbon and oscillations were observed both in the plasma and divertor layer, followed by an outflow of accelerated electrons.

57517 **Experimental study of magnetic divertor in DIVA.** Maeda, H.; Sengoku, S.; Kimura, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp 377-385 of Plasma physics and controlled nuclear fusion research 1978. Vol. 1. Vienna, Austria; International Atomic Energy Agency (1979).

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The metal-impurity origin on the surface of the actual first wall is the self-sputtering of gold ions in the DIVA device. The efficiency of shielding action by the scrape-off plasma against the aluminium blow-off is about 95% and 80-85%, with and without the divertor, respectively. Roughly 0.3% of the aluminium atoms injected into the scrape-off plasma in the burial chamber penetrate into the main plasma owing to the impurity backflow from the burial chamber. The divertor suppresses the increase of the radiation loss when the plasma current is increased, increases energy confinement time by a factor of 2.5, and provides the stable low-q discharge, typically q=2. Stable low-q discharges, typically q=1.7, anti n=1.1x10^{14}cm^{-3}, anti β=0.8% and tausub(E)=5.7ms, are also obtained even in undiverted discharges by reducing the impurity effect by employing the clean titanium shell surface.

GENERAL AND MISCELLANEOUS

MANAGEMENT

57518 (BLG—520) **Annual scientific report 1976.** Billiau, R.; Kirk, F.; Proost, J. (eds.). (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1977. vp. Dep. NTIS (US Sales Only), PC A09/MF A01.

This report of the Centre d'Etude de l'Energie Nucleaire - Studiecentrum voor Kernenergie gives a survey of the scientific and technical work done in 1976. The research areas were as follows: 1. The sodium-cooled fast reactors and, in particular, mixed oxide fuels, carbide fuel, materials development, reprocessing, fast reactor physics, safety and instrumentation, and sodium technology. 2. The gas-cooled reactors as gas-cooled fast and high-temperature reactors. 3. The light water reactors, in particular, the BR3 reactor, light-water reactor fuels and pluutonium recycling. 4. Applied nuclear research, waste processing and disposal: safeguards, fusion research and lithium technology. 5. Basic and exploratory research in materials science and nuclear physics. 6. Non-nuclear research and development such as in air pollution, pollution abatement and waste handling, fuel cells and applied electrochemistry.

57519 (ORNL/CSD/TM—91) **A computerized management report for monitoring spending: a user's manual.** Stephenson, R.L. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

In an organization with budgetary constraints, it is of critical importance to monitor spending throughout the accounting period. A PL/I program was written which uses monthly cost and manpower data to generate a management report. This report displays, in tabular form, the monthly cost and manpower expenditure, cumulative expenditures for the year to date, allowable straight-line spending for the remainder of the year, etc., on an account basis. The program is also capable of displaying subtotals for groups of programs and totals for the entire division. In a year of use, the program has been shown to provide timely and concise spending information for division managers. 5 figures.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 55938

57520 (ANL—79-71(Vol.1)) **Interim report on the development and application of environmental mapped data digitization, encoding, analysis, and display software for the ALICE system. Volume I.** Amiot, L.W.; Lima, R.J.; Scholbrock, S.D.; Shelman, C.B.; Wehman, R.H. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 68p. Dep. NTIS, PC A04/MF A01.

The Applied Mathematics Division of Argonne National Laboratory has been developing the existing ALICE Image Processing System into a computer-aided digitization, encoding, analysis, and display system for mapped information pertaining to the environment and its elements. Recent software developments expanded the capabilities of the ALICE System and the scope of potential applications for the system. This interim report describes the ALICE System and the software that has been developed to date for the processing of mapped environmental information used in city and regional planning, environmental analysis, energy assessment, and resource management. 24 figures.

57521 (ANL—79-71(Vol.2)) **Interim report on the development and application of environmental mapped data digitization, encoding, analysis, and display software for the ALICE system. Volume II.** Amiot, L.W.; Lima, R.J.; Scholbrock, S.D.; Shelman, C.B.; Wehman, R.H. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 230p. Dep. NTIS, PC A11/MF A01.

Volume I of An Interim Report on the Development and Application of Environmental Mapped Data Digitization, Encoding, Analysis, and Display Software for the ALICE System provided an overall description of the software developed for the ALICE System and presented an example of its application. The scope of the information presented in Volume I was directed both to the users and developers of digitization, encoding, analysis, and display software. Volume II presents information which is directly related to the actual computer code and operational characteristics (keys and subroutines) of the software. Volume II will be of more interest to developers of software than to users of the software. However, developers of software should be aware that the code developed for the ALICE System operates in an environment where much of the peripheral hardware to the PDP-10 is ANL/AMD built. For this reason, portions of the code may have to be modified for implementation on other computer system configurations. 11 tables.

57522 (CONF-791043—1) **Statistical analysis of the interrupted time-series experiment: some problems and a recommended solution.** Mawhinney, T.C.; Pack, D.J. (Oak Ridge National Lab., TN (USA); Indiana Univ., Bloomington (USA)). 1979. Contract W-7405-ENG-26. 49p. (CONF-790872—1). Dep. NTIS, PC A03/MF A01.

From TIMS/ORSA national meeting; Milwaukee, WI, USA (15 Oct 1979).

The practical need for a statistical method which recognizes the possibility of observation dependencies in before-after tests of intervention effects and the complications associated with unequal sample sizes and variances in before-after time-series are recognized. Then the practical implications of modeling observation dependencies using an ARIMA model with differences in before-after N's and σ's as compared to the standard t-test and Behrens-Fisher test are evaluated by use of simulated data variations, i.e., no real change before-after versus known parametric changes before-after a hypothetical intervention. Results of both the simulation study and statistical theory support the conclusion that ARIMA models be employed to evaluate before-after (interrupted)time-series data in order to avoid the potential of biased conclusions concerning true intervention effects. 2 figures, 16 tables.

57523 (IS—4708) **ALLS, a generalized crystallographic least squares program.** Lapp, R.L.; Jacobson, R.A. (Ames Lab., IA (USA)). Aug 1979. Contract W-7405-ENG-82. 71p. Dep. NTIS, PC A04/MF A01.

A new program has been written in FORTRAN for the least-squares refinement of single crystal x-ray diffraction data. The program uses the same methods to handle symmetry, calculate derivatives, and invert the matrix as ORFLS developed at Oak Ridge but includes options for block-diagonal matrix refinement, secondary extinction refinement, reuse of the matrix on successive cycles, and several input/output options to improve the program's efficiency and utility. A complete listing of the program and detailed instructions for its use are included.

57524 (LA-UR—79-1912) **Minicomputer-based interactive image processing.** Breedlove, J.R. Jr.; Alexander, S.T. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-791104—2). Dep. NTIS, PC A02/MF A01.

From 1. international micro and mini computer conference and exposition; Houston, TX, USA (14 Nov 1979).

The Los Alamos Scientific Laboratory is developing a minicomputer-based system for interactive image processing and interactive reduction of data from photographs, radiographs, and other image-like information. This system, Digital Image Analysis and Display System (DIADS), represents an efficient alternative to existing supercomputer-based image processing for most problems. DIADS consists of two linked minicomputers with conventional computer peripherals, special tricolor image processing hardware, and extensive supporting software for handling large arrays of data. DIADS is described, and examples of image processing and image analysis results are shown. 5 figures.

57525 (ORNL/CSD—40) **Mathematics and Statistics Research Department progress report for period ending June 30, 1979.** Gardiner, D.A.; Beauchamp, J.J.; Gray, L.J.; Lever, W.E.; Shepherd, D.E. (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 87p. Dep. NTIS, PC A05/MF A01.

This is the twenty-second in the series of progress reports of the Mathematics and Statistics Research Department and its predecessor organizations. Part A reports research progress in biomedical and environmental applications, materials science applications, model development and evaluation, moving-boundary problems, multivariate multipopulation classification, numerical linear algebra, risk analysis, and complementary areas. The results of collaboration with other researchers on problems in biology, chemistry, energy, engineering, environmental sciences, geology, health and safety research, information sciences, and material sciences are recorded in Part B. Parts C, D, and E contain short accounts of educational activities, lists of written and oral presentations of research results, and a list of other professional activities in which the staff was engaged. Although a few results are shown, the reports in this volume are only of extended abstract length. One may expect completed research to be reported in the usual channels. 6 figures, 2 tables. (RWR)

57526 (ORNL/CSD/TM—82) **PIE: a FORTRAN subroutine for plotting circles, concentric circles, pie charts, and shaded pie charts.** Dillard, C.A. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

A set of FORTRAN subroutines designed to draw circles, concentric circles, pie charts, and shaded pie charts is described. These subroutines run on IBM/360 computers and the PDP-10. Subroutine PLOT is the only plotting routine used; thus drawings can be made on Versatec, Calcomp, or Tektronix plotters. 7 figures.

57527 **Rationale of a standard interchange format.** Brooks, A A. (Oak Ridge National Lab., TN (USA); Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). pp 297-301 of Generalized data

management systems and scientific information. Paris, France; OECD Nuclear Energy Agency (1978).

The proposed draft, American National Standard Specifications for a data descriptive file for Information Interchange, which is in development by the ANSI/X3L5 committee is described. The standard is suited for R and D data interchange in an ASCII character mode.

57528 (SAND—79-8048) **Interface Routines, a program for the Tektronix 4051 Graphics Terminal.** Muir, J.F. (Sandia Labs., Livermore, CA (USA)). Sep 1979. Contract EY-76-C-04-0789. 34p. Dep. NTIS, PC A03/MF A01.

The computer program described in this report was written for the Tektronix 4051 Graphics Terminal. This program, Interface Routines, was created primarily to improve the turnaround time for PL/M program modification. By use of the 4051 terminal and Interface Routines, a PL/M program residing in SLL's CDC-6600 can be modified, compiled, and transferred to a MCS-80 microprocessor in a few minutes. Additionally, Interface Routines allows the 4051 terminal to be used as an input/output device and as a means of locally storing and transferring both computer programs and data between external mainframe computers. The program is written in Tektronix Basic, occupies 16K bytes of memory, and is stored on a DC-300A magnetic tape cartridge. 5 figures, 3 tables.

57529 (UCRL—83238) **Simulation study of the traffic dependent performance of a prioritized, CSMA broadcast network.** Watson, W.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1979. Contract W-7405-ENG-48. 25p. (CONF-791023—2). Dep. NTIS, PC A02/MF A01.

From 4. local computer networks conference; Minneapolis, MN, USA (22 Oct 1979).

Portions of document are illegible.

A CSMA broadcast network engaged in short to very long message transmission was studied by means of a discrete event simulation. These studies imply that no advantage is to be obtained in a two-trunk network by dedicating one trunk to long message transmission and the other to short message transmission. In addition, the throughput of a single-trunk, multiport network is significantly reduced when one of the ports is attached to a host with a significantly slower host-to-port transfer rate than the others. Finally, a CSMA broadcast network wherein all hosts interact with the same destination (and not each other) can be prone to thrashing, especially at high loads. The networks summarized behave as described largely because the critical resource is host/adapter availability and speed, and not the number or capacity of the trunks, and secondarily because of certain inadequacies of the second-level protocol. 8 figures.

57530 (UCRL—83238(Rev.1)) **Simulation study of the traffic dependent performance of a prioritized, CSMA broadcast network.** Watson, W.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1979. Contract W-7405-ENG-48. 9p. (CONF-791023—2(Rev.1)). Dep. NTIS, PC A02/MF A01.

From 4. local computer networks conference; Minneapolis, MN, USA (22 Oct 1979).

A CSMA broadcast network engaged in short to very long message transmission was studied by means of a discrete event simulation. These studies imply that no advantage is to be obtained in a two-trunk network by dedicating one trunk to long message transmission and the other to short message transmission. In addition, the throughput of a single-trunk, multiport network is significantly reduced when one of the ports is attached to a host with a significantly slower host-to-port transfer rate than the others. Finally, a CSMA broadcast network wherein all hosts interact with the same destination (and not each other) can be prone to thrashing, especially at high loads. The networks summarized behave as described largely because the critical resource is host/adapter availability and speed, and not the number or capacity of the trunks, and secondarily because of certain inadequacies of the second-level protocol. 8 figures.

57531 **ILUCG algorithm which minimizes in the Euclidean norm.** Petravic, M.; Kuo-Petravic, G. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *J. Comput. Phys.;* **32**: No. 2, 263-269(Aug 1979).

This paper presents an algorithm which solves sparse systems of linear equations of the form Ax=y, where A is non-symmetric, by the Incomplete LU Decomposition-Conjugate Gradient (ILUCG) method. The algorithm minimizes the error in the Euclidean norm parallelx/sub i/—xparallel$_2$, where x/sub i/ is the solution vector after the ith iteration and x the exact solution vector. The results of a test on one real problem indicate that the algorithm is likely to be competitive with the best existing algorithms of its type.

57532 (JPRS—73388) **Translations on USSR science and technology: Physical Sciences and Technology, No. 67.** 7 May 1979. Translation of various articles. 42p. NTIS.

News items on USSR scientific organization, cybernetics, computers, and automation technology are included. A separate abstract was prepared for the paper on the power industry application of MHD technology. (WHK)

57533 **Clock distribution system for digital computers.** Wyman, R.H. (to Dept. of Energy). US Patent Application 966,710. 5 Dec 1978. 14p.

Apparatus using logic, delay, energy storage, filters and signal characteristic detectors for eliminating in each clock distribution amplifier of a clock distribution system the disabling error due to one pulse overtaking a prior clock pulse is described. 11 figures.

INFORMATION HANDLING

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57534 (SAND—78-1348) **Generalized means of expressing relationships in a data base.** Hall, R.C. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract EY-76-C-04-0789. 40p. Dep. NTIS, PC A03/MF A01.

The need to store relationships as well as data is identified as a requirement for data base management systems. Generalization is suggested as a medium through which this requirement can be effectively met. Generalized expressions of relationships in compact, integer form are introduced. A sufficient repertoire of operations possible on the expressions is given to permit data retrieval and maintenance. 4 figures.

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Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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EX-76-A-01-2295	Massachusetts Inst. of Tech., Cambridge (USA)	
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EX-76-A-29-1012	Jet Propulsion Lab., Pasadena, CA (USA)	
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EX-76-A-29-1037	Wyle Labs., Huntsville, AL (USA). Solar Energy Systems Div.	
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EX-76-A-29-1060	Burns and McDonnell Engineering Co., Kansas City, MO (USA)	
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EX-76-C-01-2028	Delaware Univ., Newark (USA)	
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EX-76-C-01-2247	Texaco, Inc., Montebello, CA (USA). Montebello Research Lab.	
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EX-76-C-01-2298	Department of Energy, Washington, DC (USA). Div. of Coal Conversion	
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EX-76-C-01-2338	Lehigh Univ., Bethlehem, PA (USA)	
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EX-76-C-01-2408	Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering	
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EX-76-S-01-2454	Auburn Univ., AL (USA). Coal Conversion Lab.	
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EY-76-C-02-1195	Illinois Univ., Urbana (USA). Dept. of Physics	
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EY-76-C-02-1545	Ohio State Univ., Columbus (USA). Dept. of Physics	
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EY-76-C-02-1764	Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy	
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EY-76-C-02-3069	Massachusetts Inst. of Tech., Cambridge (USA)	
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EY-76-C-02-3071	Pennsylvania Univ., Philadelphia (USA)	
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	4:56739	ORAU/IEA—78-25
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EY-76-C-06-2130	Minnesota Univ., Minneapolis (USA). Mineral Resources Research Center	
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EY-76-S-02-2807	Kansas State Univ., Manhattan (USA). Dept. of Chemistry	
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EY-76-S-05-4721	North Carolina State Univ., Raleigh (USA). Dept. of Nuclear Engineering	
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EY-76-S-05-4942	Georgia Inst. of Tech., Atlanta (USA). Coll. of Engineering	
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EY-76-S-05-5173	Maryland Univ., College Park (USA). Dept. of Chemistry	
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EY-77-S-02-4579	Pittsburgh Univ., PA (USA). Dept. of Civil Engineering	
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	4:57367	*See* LA-7892C
	4:57368	*See* LA-7892C
CONF-790148-	(IEEE workshop on physics and engineering in computerized tomography, Newport Beach, CA, USA, 17-19 Jan 1979)	
2	4:57171	*See* LBL-8627
CONF-790216-	(1979 SAE Congress and Exposition Engine Modeling Session, Detroit, MI, USA, 26 Feb-2 Mar 1979)	
5	4:56867	Warrendale, PA; Society of Automotive Engineers, Inc. (1979).
CONF-790341-	(International conference on modulated structures, Kailua-Kona, HI, USA, 22-25 Mar 1979)	
	4:56883	53: No. 1, 223-225(1 Jul 1979)
	4:56884	53: No. 1, 226-228(1 Jul 1979)
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	4:56912	53: No. 1, 187-192(1 Jul 1979)
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	4:56936	53: No. 1, 403-405(1 Jul 1979)
	4:56953	53: No. 1, 72-74(1 Jul 1979)
	4:57379	53: No. 1, 21-29(1 Jul 1979)
	4:57380	Copyright Clearance Center, Inc., Box 765, Schenectady, NY 12301
CONF-790365-	(16. rencontre de moriond, Les Arcs, Savoie, France, 17-23 Mar 1979)	
8	4:57288	*See* COO-3071-242
CONF-790387-	(VGB conference on gasification of coal in power engineering, Dortmund, F.R. Germany, 27-28 Mar 1979)	
1	4:55948	*See* TIS-6250
CONF-790388-	(The Einstein centennial symposium, Jerusalem, Israel, 14-23 Mar 1979)	
1	4:57305	*See* SLAC-PUB-2363
CONF-790486-	(Biology division research conference on the scientific basis of toxicity assessment, Gatlinburg, TN, USA, 15-19 Apr 1979)	
5	4:57184	Dep. NTIS, PC A02/MF A01
CONF-7904106-	(61. AWS annual meeting, Los Angeles, CA, USA, 14-18 Apr 1979)	
1	4:56876	Dep. NTIS, PC A02/MF A01
CONF-7904108-	(JOWOG 9 meeting, Albuquerque, NM, USA, Apr 1979)	
1	4:56983	*See* UCRL-82623
CONF-790541-	(International Solar Energy Society meeting, Atlanta, GA, USA, 28 May 1979)	
56	4:56277	*See* ISM-213
CONF-790598-	(Institute of gas technology symposium: advances in coal utilization technology, Clarksville, IN, USA, 14-18 May 1979)	
2	4:55950	Chicago, IL; Institute of Gas Technology (1979).
CONF-790599-	(Ammonia-from-coal symposium, Muscle Shoals, AL, USA, 8-10 May 1979)	
1	4:55951	Chicago, IL; Institute of Gas Technology (1979).
21	4:55952	Chicago, IL; Institute of Gas Technology (1979).
CONF-7905100-	(American Gas Association transmission conference, New Orleans, LA, USA, 21-23 May 1979)	
1	4:55953	Chicago, IL; Institute of Gas Technology (1979).
CONF-7905101-	(Mid-American biomass energy workshop, West Lafayette, IN, USA, 21-23 May 1979)	
1	4:56246	Inst. of Gas Technology, Chicago, IL
CONF-7905105-	(Conference on using land to save energy, Chicago, IL, USA, 18-19 May 1979)	
2	4:56816	Dep. NTIS, PC A02/MF A01
CONF-7905106-	(1. international mine drainage symposium, Denver, CO, USA, 20-23 May 1979)	
1	4:55987	Dep. NTIS, PC A03/MF A01
CONF-7905111-	(Workshop on inner shell processes, Linz, Austria, 14-18 May 1979)	
1	4:57240	Dep. NTIS, PC A02/MF A01
CONF-7905112-	(EBT transport workshop, Gaithersburg, MD, USA, 7-9 May 1979)	
	4:57390	*See* DOE/ET-0112
	4:57391	*See* DOE/ET-0112
	4:57413	*See* DOE/ET-0112
	4:57422	*See* DOE/ET-0112
	4:57423	*See* DOE/ET-0112
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	4:57430	*See* DOE/ET-0112
	4:57431	*See* DOE/ET-0112
	4:57432	*See* DOE/ET-0112
	4:57433	*See* DOE/ET-0112
CONF-790602-	(ANS annual meeting, Atlanta, GA, USA, 3-8 Jun 1979)	
86	4:56597	*See* HEDL-SA-1698-FP
CONF-790622-	(Pulsed power conference, Lubbock, TX, USA, 12-14 Jun 1979)	
28	4:57491	*See* UCRL-82547
CONF-790632-	(JOWOG-28, Albuquerque, NM, USA, 11-14 Jun 1979)	
9	4:56983	*See* UCRL-82623
CONF-790641-	(Rare earth research conference, Fargo, ND, USA, 25-28 Jun 1979)	
9	4:56954	*See* ISM-224
CONF-790642-	(International conference on high energy physics, Geneva, Switzerland, 27 Jun-4 Jul 1979)	
5	4:57295	*See* SLAC-PUB-2362
6	4:57296	*See* SLAC-PUB-2366
CONF-790648-	(Neutrino 1979 conference, Bergen, Norway, 18-22 Jun 1979)	
6	4:57291	*See* SLAC-PUB-2357
CONF-790683-	(ONWI-LLL workshop on thermomechanical modeling for a hard rock repository, Berkeley, CA, USA, 25-27 Jun 1979)	
2	4:56119	*See* RHO-BWI-SA-21
CONF-7906106-	(International workshop on intrinsic stochasticity in plasmas, Cargese, Corsica, France, 18-22 Jun 1979)	
3	4:57434	*See* LBL-9407
CONF-7906129-	(3. international symposium on finite element methods in flow problems, Banff, Alberta, Canada, 10-13 Jun 1979)	
1	4:57028	*See* SAND-79-1373C
CONF-790703-	(4. international conference of the system safety society, San Francisco, CA, USA, 9-13 Jul 1979)	
2	4:57195	*See* SAND-79-1671C
CONF-790707-	(20. annual meeting of the Institute of Nuclear Materials Management, Albuquerque, NM, USA, 16-19 Jul 1979)	
32	4:56148	*See* HEDL-SA-1777
34	4:56147	*See* AGNS-35900-CONF-4
CONF-790741-	(DOE impact fusion workshop, Los Alamos, NM, USA, 10-13 Jul 1979)	
8	4:57494	*See* LA-UR-79-2220
CONF-790743-	(Symposium on heavy ion physics from 10-200 MeV/A, Upton, NY, USA, 16-20 Jul 1979)	
5	4:57366	Dep. NTIS, PC A02/MF A01

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CONF-790746-		(Japan-U.S. conference on normal and abnormal epidermal differentiation, Pellston, MI, USA, 30 Jul-3 Aug 1979)
1	4:57185	Dep. NTIS, PC A03/MF A01
CONF-790752-		(Workshop on the health effects of photovoltaic technology, Upton, NY, USA, 31 Jul-2 Aug 1979)
1	4:57188	*See* BNL-26481
CONF-790755-		(IAU colloquium on the structure of white dwarfs and variable degenerates, Rochester, NY, USA, 30 Jul-3 Aug 1979)
3	4:57205	*See* LA-UR-79-2611
CONF-790759-		(1. international workshop on reactive metal-air batteries, Bonn, F.R. Germany, 9-11 Jul 1979)
1(Rev.1)	4:56732	*See* UCRL-82497(Rev.1)
CONF-790760-		(US/Japan seminar on two-phase flow dynamics, Tokyo, Japan, 23 Jul-3 Aug 1979)
1	4:56637	*See* BNL-NUREG-26464
CONF-790761-		(International colloquium on materials for high-temperature energy, Toronto, Canada, 16-19 Jul 1979)
1	4:56938	Dep. NTIS, PC A02/MF A01
CONF-790762-		(14. international conference for the Society of Chronobiology, Hanover, F.R. Germany, 8-12 Jul 1979)
1	4:57168	Dep. NTIS, PC A03/MF A01
CONF-790801-		(5. international conference on the strength of metals and alloys, Aachen, F.R. Germany, Aug 1979)
3	4:56881	Dep. NTIS, PC A02/MF A01
4	4:56892	Dep. NTIS, PC A02/MF A01
CONF-790802-		(International conference on structural mechanics in reactor technology, Berlin, F.R. Germany, 13-17 Aug 1979)
49	4:56642	Dep. NTIS, PC A02/MF A01
50	4:56643	Dep. NTIS, PC A02/MF A01
51	4:56469	Dep. NTIS, PC A02/MF A01
52	4:56644	Dep. NTIS, PC A02/MF A01
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56	4:56470	Dep. NTIS, PC A02/MF A01
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58	4:57492	Dep. NTIS, PC A02/MF A01
59	4:56471	Dep. NTIS, PC A02/MF A01
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64	4:57002	Dep. NTIS, PC A02/MF A01
65	4:56651	Dep. NTIS, PC A02/MF A01
66	4:56652	Dep. NTIS, PC A02/MF A01
71	4:56613	Dep. NTIS, PC A02/MF A01
73	4:56472	Dep. NTIS, PC A02
CONF-790803-		(14. intersociety energy conversion conference, Boston, MA, USA, 5-10 Aug 1979)
48	4:56872	Dep. NTIS, PC A02/MF A01
51	4:57477	Dep. NTIS, PC A02/MF A01
52	4:57508	Dep. NTIS, PC A02/MF A01
53	4:56825	Dep. NTIS, PC A02/MF A01
CONF-790805-		(DOE symposium on enhanced oil and gas recovery and improved drilling technology, Tulsa, OK, USA, 22-24 Aug 1979)
P1	4:56016	Dep. NTIS, PC A18/MF A01
CONF-790806-		(SIGGRAPH '79, Chicago, IL, USA, 6-10 Aug 1979)
3	4:57496	*See* LBL-9146
CONF-790815-		(Cryogenic engineering conference, Madison, WI, USA, 21-24 Aug 1979)
19	4:57006	Dep. NTIS, PC A02/MF A01
20	4:57489	Dep. NTIS, PC A02/MF A01
23	4:57031	Dep. NTIS, PC A02/MF A01
24	4:57007	Dep. NTIS, PC A02/MF A01
26	4:57013	*See* LA-UR-79-2309
27	4:57014	*See* LBL-9701
29	4:56823	Dep. NTIS, PC A02/MF A01
CONF-790816-		(International meeting on fast reactor safety technology, Seattle, WA, USA, 19-23 Aug 1979)
43	4:56565	*See* LA-UR-79-2185
55	4:56653	Dep. NTIS, PC A02/MF A01
56	4:56658	*See* HEDL-SA-1713-FP
CONF-790819-		(Topical meeting on photoacoustic spectroscopy, Ames, IA, USA, 1-3 Aug 1979)
7	4:57077	*See* LBL-9185
CONF-790822-		(87. AICHE national meeting, Boston, MA, USA, 19 Aug 1979)
13	4:55963	Dep. NTIS, PC A03/MF A01
CONF-790828-		(7. international colloquium on gas-dynamics of explosions and reactive systems, Gottingen, F.R. Germany, 20-24 Aug 1979)
1(Rev.1)	4:56040	*See* UCRL-82293(Rev.1)
CONF-790836-		(16. international cosmic rays conference, Kyoto, Japan, 6-18 Aug 1979)
5	4:57203	*See* UCRL-83295
CONF-790843-		(8. international conference on atomic collisions in solids, Hamilton, Canada, 13-17 Aug 1979)
3	4:57226	Dep. NTIS, PC A02/MF A01
4	4:57222	Dep. NTIS, PC A02/MF A01
6	4:57227	Dep. NTIS, PC A02/MF A01
CONF-790847-		(International conference on high energy physics and nuclear structure, Vancouver, Canada, 13-17 Aug 1979)
6	4:57282	*See* BNL-26604
8	4:57079	*See* SLAC-PUB-2378
10	4:57336	*See* LA-UR-79-2430
11	4:57309	*See* LA-UR-79-2616
CONF-790852-		(IGT symposium on energy modeling II: the interface between model builder and decision maker, Colorado Springs, CO, USA, 13-17 Aug 1979)
1	4:56738	Dep. NTIS, PC A02/MF A01
CONF-790853-		(ONR workshop on electron generators of coherent radiation, Telluride, CO, USA, 13-17 Aug 1979)
2	4:57023	*See* LA-UR-79-2176
CONF-790854-		(Mechanical and mag. energy storage contractor, Washington, DC, USA, 19-22 Aug 1979)
3	4:56220	*See* COO-4094-57
CONF-790855-		(Symposium on instrumentation and control for fossil energy processes, Denver, CO, USA, 20-22 Aug 1979)
3	4:55929	Dep. NTIS, PC A02/MF A01
CONF-790859-		(International conference on liquid scintillation counting--recent applications and development, San Francisco, CA, USA, 21-24 Aug 1979)
2	4:57070	*See* LA-UR-79-2288
CONF-790861-		(11. international conference on the physics of electronic and atomic collisions, Kyoto, Japan, 29 Aug-4 Sep 1979)
1	4:57235	Dep. NTIS, PC A02/MF A01
2	4:57223	Dep. NTIS, PC A02/MF A01
3	4:57236	Dep. NTIS, PC A02/MF A01
4	4:57237	Dep. NTIS, PC A02/MF A01
6	4:57238	Dep. NTIS, PC A02/MF A01
CONF-790862-		(3. international conference on phonon scattering in condensed matter, Providence, RI, USA, 28-31 Aug 1979)
3	4:57373	*See* BNL-26610
CONF-790863-		(2. international conference on secondary ion mass spectrometry, Palo Alto, CA, USA, 26-31 Aug 1979)
1	4:56882	Dep. NTIS, PC A04/MF A01
CONF-790864-		(Community renewable energy systems conference, Boulder, CO, USA, 20-21 Aug 1979)
1	4:56740	Dep. NTIS, PC A02/MF A01
CONF-790867-		(4. international symposium on plasma chemistry, Zurich, Switzerland, 27 Aug-1 Sep 1979)
1	4:57412	Dep. NTIS, PC A02/MF A01
CONF-790870-		(International astronomical union meeting, Montreal, Canada, 20-23 Aug 1979)
1	4:57201	*See* LA-UR-79-2383
CONF-790872-		(Academy management meeting, Atlanta, GA, USA, Aug 1979)
1	4:57522	*See* CONF-791043-1
CONF-790878-		(International summer institute on surface science, Milwaukee, WI, USA, 13-17 Aug 1979)
1	4:57224	*See* LBL-9596
CONF-790882-		(10. international radiocarbon conference, Bern, Switzerland, 19-26 Aug 1979)
1	4:57239	Dep. NTIS, PC A02/MF A01
CONF-790902-		(Impact of advanced systems on scientific computations, Livermore, CA, USA, 12-13 Sep 1979)

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1	4:57436	*See* UCRL-83206
CONF-790906-	(Geothermal Resources Council annual meeting, Reno, NV, USA, 24 Sep 1979)	
29	4:56356	*See* SAND-79-7085C
30	4:56355	*See* SAND-79-7084C
32	4:56340	Dep. NTIS, PC A02/MF A01
CONF-790909-	(International conference on magnetism, Munich, F.R. Germany, Sep 1979)	
8	4:57375	*See* ISM-228
9	4:56909	*See* ISM-218
CONF-790922-	(Workshop on nude mice, Bozeman, MT, USA, 6-9 Sep 1979)	
1	4:57131	*See* LA-UR-79-2424
CONF-790923-	(Decontamination and decommissioning of nuclear facilities conference, Sun Valley, ID, USA, 16-19 Sep 1979)	
5	4:57115	Dep. NTIS, PC A02/MF A01
7	4:56146	*See* RHO-SA-103
CONF-790924-	(Frontiers of power generation conference, Stillwater, OK, USA, 24-25 Sep 1979)	
1	4:56265	*See* SAND-79-1730C
CONF-790926-	(8. IEEE international congress on instrumentation in aerospace simulation facilities, Monterey, CA, USA, 24-26 Sep 1979)	
1	4:57078	*See* SAND-79-0750C
CONF-790927-	(Linear accelerator conference, Montauk, NY, USA, 10-14 Sep 1979)	
2	4:57032	*See* LA-UR-79-2330
3	4:57034	*See* LA-UR-79-2502
4	4:57058	*See* LA-UR-79-2548
5	4:57037	*See* LA-UR-79-2542
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22	4:57060	*See* LA-UR-79-2552
CONF-790928-	(International meeting on monitoring of Pu-contaminated waste, Ispra, Italy, 25-28 Sep 1979)	
1	4:56151	*See* LA-UR-79-2416
CONF-790935-	(IAEA specialists meeting on defected zirconium alloy clad ceramic fuel in water cooled reactors, Chalk River, Canada, 17-21 Sep 1979)	
1	4:56654	Dep. NTIS, PC A02/MF A01
2	4:56655	Dep. NTIS, PC A02/MF A01
3	4:56390	Dep. NTIS, PC A02/MF A01
CONF-790944-	(4. international congress on rock mechanics, Montreux, Switzerland, 2-8 Sep 1979)	
1	4:56118	*See* RHO-BWI-SA-20
CONF-790946-	(Nobel symposium on chemistry and geochemistry of solutions at high temperature and pressure, Bofors, Karlskoga, Sweden, 16-21 Sep 1979)	
1	4:56975	*See* LBL-9660
CONF-790948-	(Annual meeting of the American Institute of Professional Geologists, Lafayette, LA, USA, 21 Sep 1979)	
1	4:56126	*See* UCRL-83285
CONF-790949-	(Energy resources workshop, Oak Ridge, TN, USA, 24-26 Sep 1979)	
1	4:56078	Dep. NTIS, PC A02/MF A01
CONF-790954-	(18. international conference on solar energy, Milan, Italy, 23-27 Sep 1979)	
1	4:56321	*See* SAND-79-1803C
CONF-790958-	(36. meeting of the pulverized fuel panel of the International Flame Research Foundation, Amsterdam, Netherlands, Sep 1979)	
1	4:56012	*See* SAND-79-8729
CONF-790962-	(Conference on industrial use of thermochemical data, Surrey, UK, 12-13 Sep 1979)	
1	4:56079	*See* ISM-219
CONF-791013-	(26. national vacuum symposium, New York, NY, USA, 2-5 Oct 1979)	
2	4:56313	*See* SAND-79-1754C
4	4:57266	*See* SAND-79-1240C
CONF-791017-	(7. international conference on chemical vapor deposition, Los Angeles, CA, USA, 14-19 Oct 1979)	
6	4:57251	*See* LBL-9265
8	4:56826	*See* LMSC/D-672691
CONF-791020-	(9. annual Rocky Mountain ground-water conference, Reno, NV, USA, 22-23 Oct 1979)	
1	4:56335	Dep. NTIS, PC A02/MF A01
CONF-791022-	(4. national passive solar energy conference, Kansas City, KS, USA, 3-5 Oct 1979)	
3	4:56308	*See* ISM-233
4	4:56280	*See* LA-UR-79-2495
5	4:56278	*See* ISM-231
6	4:56199	*See* ISM-235
7	4:56279	*See* ISM-232
92	4:56310	*See* LBL-9697
CONF-791023-	(4. local computer networks conference, Minneapolis, MN, USA, 22-23 Oct 1979)	
2	4:57529	*See* UCRL-83238
2(Rev.1)	4:57530	*See* UCRL-83238(Rev.1)
CONF-791028-	(Conference on electrical insulation and dielectric phenomena, Whitehaven, PA, USA, 21-25 Oct 1979)	
2	4:57022	*See* LA-UR-79-1655
CONF-791031-	(6. conference on probability and statistics in atmospheric sciences, Banff, Alberta, Canada, 9-12 Oct 1979)	
1	4:56363	*See* UCRL-82531
CONF-791035-	(32. annual gaseous electronic conference, Pittsburgh, PA, USA, 9-12 Oct 1979)	
1	4:57230	*See* UCRL-82994
CONF-791037-	(IEEE nuclear science symposium, San Francisco, CA, USA, 17-19 Oct 1979)	
1	4:57069	*See* LA-UR-79-1246
CONF-791041-	(Workshop on geothermal drilling fluids, Houston, TX, USA, 9 Oct 1979)	
2	4:56357	*See* SAND-79-7091C
CONF-791043-	(TIMS/ORSA national meeting, Milwaukee, WI, USA, 15-17 Oct 1979)	
1	4:57522	Dep. NTIS, PC A03/MF A01
CONF-791102-	(8. symposium on engineering problems of fusion research, San Francisco, CA, USA, 13-16 Nov 1979)	
1	4:57495	*See* LA-UR-79-2329
CONF-791103-	(American Nuclear Society meeting, San Francisco, CA, USA, 12-16 Nov 1979)	
31	4:56093	*See* DP-MS-79-40
CONF-791104-	(1. international micro and mini computer conference and exposition, Houston, TX, USA, 14-16 Nov 1979)	
2	4:57524	*See* LA-UR-79-1912
CONF-791107-	(49. annual international SEG meeting, New Orleans, LA, USA, 4-8 Nov 1979)	
1	4:55947	*See* SAND-79-1022C
CONF-791108-	(72. AICHE meeting, San Francisco, CA, USA, 25-29 Nov 1979)	
5	4:56053	*See* UCRL-83348
CONF-791116-	(11. national SAMPE technical conference, Boston, MA, USA, Nov 1979)	
2	4:56982	*See* UCRL-82155
CONF-791117-	(ANS topical conference, Kiawah Island, SC, USA, 26-19 Nov 1979)	
2	4:56150	*See* LA-UR-79-1476
CONF-791205-	(ASME winter annual meeting, New York, NY, USA, 2-7 Dec 1979)	
4	4:57270	*See* KAPL-4123
6	4:56312	*See* SAND-79-0726C
11	4:57027	*See* LBL-9092
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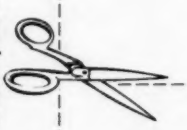

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